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# EMPIRICAL FLUTTER PREDICTION METHOD



Dr. J.K. Casey GE Aircraft Engines Advanced Technology Operation Cincinnati, Ohio 45215

5 March 1988

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Zzichard - Martin

HORRE L. MARTIE, Project Engineer subressor Research Group

TRANCIS F. OSTDIEK, Chief

Technology Branch

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COMERT E. PENDERSON
Seputy for Technology
Furting Engine Division

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points in a literal sense, but are correct in a broader practical sense for 79% of the points.

When the hyperplanes were applied to 51 validation test points taken from several actual engine/rig test data, they gave virtually no correct results. Perturbing the data  $\frac{1}{2}$  10% brought no improvement.

This result is not immediately explainable. A review of the theory and application has offered no answer. However, several questions are raised by the review. Exploration of these questions might lead to an applicable empirical model for stability predictions.

Additional research is needed to determine if the hyperplanes predict the stability conditions of points from the Annular Cascade Data Base which were not used in their construction. Furthermore, it is not known how the operational map predicted by the hyperplanes compares with the true map. Work needs to be done to determine if there is a difference between the Annular Cascade and engines beyond what is reflected in the aeromechanical variables selected for analysis. There is the possibility that some engine points are surrounded by Annular Cascade test points having a different stability condition.



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#### Summary

The design of advanced technology engines is often limited by compressor blade instability or flutter. The lack of adequate design tools can produce overly conservative designs with less than maximum levels of performance, or blade flutter can result, leading to a complete destruction of an engine. Consequently, the accurate prediction of the flutter boundaries is a key requirement for the successful design of future engines.

With the absence of adequate theoretical analyses, partially because of the lack of detailed flow information, but largely because of the complexity of the unsteady flow fields present during stall and choke flutter, it is necessary to develop valid empirical prediction design systems for flutter-free designs based on representative flutter data.

The available flutter data obtained on component or engine development programs were however very limited. These data provided only a small window in both operational characteristics and necesary data required to quantify detail aerodynamics and mechanical parameters in the flutter region. In view of these limitations, an Air Force sponsored program "Experimental Analysis of Blade Instability" (Contract F33615-76-C-2035) was initiated to widen the data window for both stall and choke flutter. In this program, numerous tests were conducted using a stationary annular cascade. A systematic variation of aerodynamic and structural parameters was made to provide a flutter data bank for both flutter regimes. The primary parameters varied included design reduced velocity, solidity, relative density, leading edge mach number, and incidence angle, all for front stage designs.

As an extension to this program, other variables such as camber, stagger, and frequency tuning were investigated, under Company sponsorship, to determine their effects on the stall and choke flutter boundaries. The data bank generated as a result of these experimental programs consists of several thousand data points.

An empirical prediction design system for the onset of flutter based on regression analysis, was attempted as part of the Annular Cascade program. The intent was to parameterize these data to identify the significant flutter parameters and subsequently to determine the appropriate design format, requirements, and procedures. The prediction correlation was not totally successful. Although the data did collapse using the developed Standard Day Flutter Parameter, FP<sub>SD</sub>, the distinction between the flutter and stable points was at times ambiguous.

The results of this regression study indicated that either additional variables or other combinations of the present variables need to be established to provide adequate separation between the stable and flutter data points. Also the regression study showed the need to utilize geometric methodology that would directly address the geometric problem of separating the stable and flutter points, and the various types of flutter points.

The present program was undertaken to develop the appropriate geometric methodology and apply it to the Annular Cascade Data Base. The objective was to predict stall and choke flutter and then to validate the methodology using available engine data.

#### Acknowledgments

Drs. Ron B. Fost and Pat M. Niskode have provided all of the aeromechanical background and guidance which have gone into this work and, in particular, an in-depth knowledge of the Annular Cascade test vehicle and resulting data base. The Validation Points were supplied and interpreted by Dr. Fost.

Mike Stallone and, initially, Bob Jutras provided the initiative to conceive this work and the ongoing oversight.

Gerald Black provided expert programming help in converting GALACTIC from the Honeywell DPS90 to the VAX4.

Joe McKenzie, Vince Gallardo, and Dr. Frank Sagendorph provided valuable counsel.

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#### 1.0 GALACTIC Computer Program

The name is an acronym for Geometric Analysis of Large Arrays Containing Three or more Independent Coordinates.

As the name indicates, the program's capabilities are not at all specific to the flutter prediction problem while all its capabilities were intended to be useful for that problem, but are much more generic.

The fundamental point of view underlying GALACTIC is as follows: If, in the flutter prediction problem, there were only two (possibly three) independent variables — for example temperature and pressure, the test points would be plotted versus these two variables and labeled according to the stability condition that was observed. The points of the same stability condition would then be enclosed by a curve to define a region where that stability condition would be expected to prevail for engine data not in the data base.

The intent of GALACTIC is simply to extend to higher dimensional space the geometric analysis which is so intuitive and straightforward in two or possibly three dimensional spaces.

Some of the geometric tasks that the human eye does so effortlessly in two dimensions are as follows:

- o Normalize variables to comparable scales
- o Shape, size and orientation of groupings of points whether grouped by like stability condition or grouped by geometric adjacency
- o Extension of points of like stability condition into continuous enclosing regions where that stability condition prevails
- o Decision lines between the regions by which to predict the stability condition of a new point whose stability condition was unknown.

It is a simple yet accurate statement to say that GALACTIC and the methodology it embodies intends to translate these geometric tasks into algebraic tasks and then to extend these to higher dimensions.

The programming aspects will be described first, and then the underlying mathematical technology it embodies.

#### 1.1 <u>Programming Aspects</u>

GALACTIC is written in FORTRAN 77. Its development was carried out mostly on the Honeywell DPS92 computer, but it was subsequently transferred to the VAX4 computer where it is now running. Its listing currently is 4875 lines long, of which 2661 lines are in the main program and the remaining 2214 lines are in subroutines.

Among the subroutines, twelve are from the Honeywell subroutine library supplied by the International Mathematical and Statistical Libraries; these routines were part of GALACTIC as it was being developed on the Honeywell computer and were subsequently transferred to the VAX4 when GALACTIC as a whole was moved to that computer. These routines are; ZX1LP, ZX3LP, LSVDB, LSVDF, LSVG1, LSVG2, UERSET, UERTST, UGET10, USPKD, VHS12, SROTG. They occupy 1142 lines of the listing.

The program can be run in batch or time sharing mode; it will detect which is being used. If in the batch mode, it must be supplied with a file containing input in the order in which it is needed.

The program input will be described first, then the output, followed by the logical sequence of the computation. The mathematical methodology is presented in the succeeding section. Actually, these four parts are so interdependent that they must be read in coordination with one another.

#### 1.1.1 Program Input

The program input will be described in the time sharing mode with an occasional comment concerning batch usage. Generally, there is no distinction between the two; the program in one case reads the time sharing terminal and in the other case it reads a data file.

To facilitate the exact definition of the input, the read statement will be located in the program (listing as of 16:31 on July 20, 1987); for example, S580-2 means 2 lines prior to statement labeled 580.

All input read statements are preceded by prior prompts explaining what input is needed by the read statement. The prompts will be shown here, followed by any needed explanation. The statement number refers to the read statement, not the prompt.

- "Enter number and names of sample files, words/record, Y/N to clearfiles." Each record on an input file contains the data for a test point from the Annular Cascade Data Base. The names should be in single quotes for the VAX4. Clearfiles allow usage of temporary data files left over from a prior run. 'Y' or 'N' must also be in single quotes.
- S250+1 "Enter N (LE 14), then name N variables." These identify the words from each test point record which will be used to describe a test point. The words are named by their numerical order.
- "Which other variable identifies subsets (O if none)." This is the number of the word which contains the identification of the set to which the point belongs. If the set is unknown, the identification code "99" is used. The omission of a set identification variable, while possible in early versions of the program, may not lead to valid results in the current program, and should be avoided.

- S290+1 "Enter N (LE 14), then ID of N sets to be excluded."
- S295+4 "Enter N (LE 20), then name N points to be excluded."
- S295+10 "Enter N, then N pairs of ID's to be labeled as the first."

  The test points from the data base are identified by the numerical order in which they are read in by the program, including test points read in from any prior files. If "a pair of ID's is labeled as the first," any points bearing the second ID will be altered so that they bear the first ID.

  Thus, the two sets are combined under the label of the first set.
- "Choose typical scale options (MIN, MAX, AVER, SIGMA, MID RANGE, SPECIAL." The typical value is subtracted from each test point variable, and the result is divided by the scale value. SIGMA means standard deviation of the sample. MID means average of the MAX and MIN values. The options listed, except for SPECIAL, call upon the program to use the values it has computed from the test points read in. There are six other options: MNU, MXU, AVU, SGU, MDU, RNU which are like the first six except that they were earlier computed from all the files in the sample (891 data points) from the Data Base and are contained in S110+4 to S120-2. SPECIAL allows the user to enter typical and scale values for the NV variables being used. In this case, there will be two additional prompts:
- S540+1 "Enter typical values for the NV variables."
- S570+1 "Enter scale values for the NV variables."
- S580+3 "Enter count of bonded points (I & J forced into same cluster."

- "Enter the NBOND pairs of point numbers." The first read acquires NBOND, which is used in the second read. If point number I and point number J are found to be in different clusters, the two clusters will be combined.
- S630+5 "Enter 0 or 1 to notwrite, or write following output options."

"For alldata: SMN, NTR, NPT, BAX, BTR, BPT."

- S630+9 "For setdata: IPI, MEM, DSJ, HPL, BAX, PRJ, BTR, CGR, COR, EST, HPP, HPQ."
- S630+13 "For clustrs: EDS, SDS, STP, FPT, MEM, CCD, BAX, PRJ, BTR, CGR, COR, SUR."

The input for the first read is a six-digit word, and for the second and third read, it is a twelve-digit word, the digits being 0 or 1. The specific output options will be described in the next section on Program Output. It is important to note that calculations are omitted within GALACTIC if no output derived therefrom is requested. Thus, the running time is heavily dependent on these three output options.

S3000+3 "Name Revised Sample File & Population Files (in sample format) (" " if none)."

The files read in originally at S155+1 were the original sample files. The Revised Sample file is intended to be used in the same way in subsequent runs of GALACTIC. It attempts to extract from the original sample files and the Population files the critical test points, that is the test points that would be needed in developing revised hyperplanes. The Population files are in the same format as the original and Revised Sample files and have test points in the same stability regions, but their points were not used in constructing the hyperplanes. The underlying thought is that if there are more test points available than can be analyzed simultaneously, it is possible to pick a sample, develop hyperplanes for the sample, test these against the larger population, and revise the sample to exclude the population points which were found to be redundant.

In this way, we hope that we can find a sample of critical points which will generate hyperplanes which will be satisfied by the entire population. This concept was developed due to memory restrictions on the Honeywell DPS92, but has not proven necessary on the VAX4 due to the latter's virtual memory system.

- \$3059+1 "Enter N (LE 14), then ID of N sets to be excluded."
- S3059+4 "Enter N (LE 20), then name N population points to be excluded."
- S3054+1 "Enter N, then N pairs of ID's to be labeled as the first."

  This input has the same meaning as the input at S290+1, S295+4 and S295+10.
- S3050+1 "Revised sample file, FILINR, already exists."

  "Enter 1 to overwrite or 2 to enter new name."

  "Enter name of revised sample file."

  In case the output file FILINR already exists, the time sharing user may overwrite or supply a new name.
- S3495+4 "Enter name of next population file (" " if none)."
- S3491+2 "Enter N (LE 14), then ID of N sets to be excluded."
- S3491+5 "Enter N (LE 20), then name N population points to be excluded." This input has same meaning as preceding input.
- S4100+2 "Name input, output hyperplane file (" " to omit)." Enter, in single quotes, the name of the already existing file FILEHI of hyperplanes, as well as the designated name for FILEHO, the hyperplane file to be produced. Each record on these files describes a single hyperplane and consists of four more words than the number specified in S155+1. The first two words contain the identification for the two sets, the second two words contain the constant term of the hyperplane equation for each of the two sets and the remaining words are coefficients for each word in the test point records. In case FILEHO is an already existing file, the usual overwrite or name revision is provided for.

- "Choose to save old, new planes (O, N) for sets \_\_\_\_, \_\_\_."

  The user specified Old or New. This choice is made on the basis of output available earlier in the current run, as compared with output available in the prior runs that produced the old hyperplane equation.
- 9010+3 Enter O, N notto, to transform data per cluster N axes, N LE O per all data."
- "Enter max number of axes to be used."

  This causes the data originally read in accord with \$155+1 to be read again and then transformed from the original variables into new variables defined as the leading axes of one of the clusters, or of the entirety of the input data, i.e. the alldata axes. This option requires that the test points be similarly transformed any time they are read afresh from the Data Base files. Since this is not currently done, the option is safe to use only if the calculations required by the user do not entail rereading the test point data. This, for example, is the case if only cluster analysis is required. (This restriction on the use of this option could be easily removed if the need justified doing so.)
- S9140+2 "Enter O, 1 ifnot, if above cluster CG's to be treated as points." This option occurs only if the prior option was not exercised. It is subject to the same restriction. The idea of the option is to condense the clusters into single points situated at their center of gravity, and to reanalyze the problem in this simplified form, finding, for example, new clusters (or galaxies) made up of the old clusters much in the spirit of classical mechanics. This is, therefore, allowed to remain despite the restriction on its use, as a vestige of a possible future activation.
- S9170+1 "Enter 0,1,2 as there arent, are more cases, change case."

  If no more cases, the program stops at S9180. If there are more cases, the program either goes to the beginning S130 or to the input on bonding and output codes S580 saving the user the burden of repeating all the input.

#### 1.1.2 Program Output

The major output is the updated set of pairs of hyperplanes, which is written out on a data file. The format consists of the stability code for the first set, the stability code for the second set, the left-hand side constant for the first set, the left-hand side constant for the second set, followed by a coefficient for each of the words in the format of the test points supplied from the Angular Cascade Data Base.

Next we should note that the program input is printed out when the program operates in batch mode, so that the hard copy output would include prompts and responses in very much the same way as if the program were run in time sharing mode.

The following description of output will consist in an explanation of the thirty O or I digits in the three output code words that control program printout. Each one of these digits has a three-letter abbreviated description intended as a memory aid to the user. Digits are counted from the left of the code word; I calls for printout and O suppresses it. The first code word IOUTPUT refers to preliminary calculations and has six digits. The second code word IOUTPS refers to the set discrimination calculations and has twelve digits. The third code word IOUTPC refers to cluster analysis and has twelve digits also.

#### Output from Preliminary Calculations

- SMN (Digit 1 of IOUTPUT) Prints out for each set, the set number, the set code and the number of points. Also prints a summary of each variable showing minimum, midvalue, maximum, range, average, and sample standard deviation.
- NTR (Digit 2 of IOUTPUT) Prints the transformation from the original variables to the variables normalized by a typical value and scale factor. Also, the reverse transformation.
- NPT (Digit 3 of IOUTPUT) Prints the data points normalized by a typical value and a scale factor.

- BAX (Digit 4 of IOUTPUT) Prints for the entirety of the test points: the center of gravity, the semiaxes of bottle containing the data, the length of the semiaxes.
- BTR (Digit 5 of IOUTPUT) Prints transformation to and from the axes for the entirety of the test points.
- BPT (Digit 6 of IOUTPUT) Prints data points transformed to the axes for the entirety of the test points.

#### Output Specific To Set Discrimination

- EST (Digit 10 of IOUTPS) Prints out a matrix of Euclidean distance between pairs of sets, that is, the minimum Euclidean distance between pairs of points, one in one set, one in the other set. Also prints the maximum distance between points in the same set. In addition, the points providing these distances are shown (both if between sets, one if within sets).
- IPT (Digit 1 of IOUTPS) Prints out points of each set which are vertices due to their having a variable with a maximum or minimum value. Also, the points found to be redundant are expressed as convex linear combinations of the vertices.
- MEM (Digit 2 of IOUTPS) Prints for each point the number of the set to which it belongs. A minus sign is used to indicate that the point has been found to be redundant.
- DSJ (Digit 3 of IOUTPS) Prints whether the convex hulls of pairs of sets are disjoint. Disjointness is sought using only the first alldata axis, then the first two, etc., using no more than are necessary. Each step is reported on. If the pair of sets is not disjoint, then an intersection point is exhibited as a convex linear combination of the vertices of each set.
- HPL (Digit 4 of IOUTPS) Prints out hyperplanes to discriminate between each pair of sets. The hyperplanes are developed using as few axes as possible, beginning with the number of axes found necessary above (see DSJ). If the sets were previously judged to be disjoint, then the hyperplanes are sought with a gap; otherwise, the overlap option is used. If hyperplanes cannot be gotten successfully, then the opposite case (overlap or gap) is tried and the result is accepted. The success at each step of

this process is reported. When this is completed for all pairs of sets, the distance to each test point along the normal to each pair of hyperplanes is computed and marked with E in case the point violates a hyperplane. This is printed as well as a tally of the E's. The planes may be adjusted to remove some small violations and this too is reported.

HPP (Digit 11 of IOUTPS) Prints for each test point on a Population file, the distance to the point along the normal to each pair of hyperplanes, with  $\cdot$ , or = to indicate that the point is beyond both planes, falls short of both planes, or is between both planes. Once this is completed a tally is printed showing the number of points on the Revised Sample File, the number of these which were from the original or input sample files and non-redundant, the balance being from the Population files with identification code not in the input sample file or misclassified by hyperplanes. Among those misclassified by the hyperplanes are various subcategories. The subcategories indicate whether by adjusting gaps between the planes the violation could be removed and, if so, whether not only the correct stability set but also an incorrect stability set might be indicated. The same subcategories can apply when only incorrect stability sets are indicated. (These types of category are examined more completely in the EFAGHY program.)

Non-Optional Output if computed: Prints hyperplanes in terms of the original input variables; the prior printout showed the hyperplanes in terms of the original variables transformed by subtraction of a typical value, divided by a scale value, then with center of gravity subtracted and converted to alldata axes. The conversion of the hyperplanes to original variables facilitates their application to a large number of points expressed in terms of the original variables.

HPO (Digit 12 of IOUTPS) Prints for each test point on original sample files, the distance to the point along the normal to each pair of hyperplanes. This is calculated using the test points in the original variables and the hyperplanes in the original variables. Thus, this output is a check on prior output, HPL, which it should duplicate.

#### Output Specific To Cluster Analysis

- EDS (Digit 1 of IOUTPC) Prints matrix of Euclidean distances between each pair of normalized points.
- SDS (Digit 2 of IOUTPC) Prints matrix of Stepping Stone distance between each pair of normalized points.
- STP (Digit 3 of IOUTPC) Prints matrix of count of steps between each pair of normalized points.
- FPT (Digit 4 of IOUTPC) Prints matrix of frontier points in going from one point to any other point. The ij entry is the frontier point encountered first in going from point i to point j.
- MEM (Digit 5 of IOUTPC) Prints for each test point the number of the cluster to which the point belongs, with a minus sign to denote an interior point. Also prints the count of set members in each cluster.
- CCD (Digit 6 of IOUTPC) Prints the Stepping Stone distance between clusters as well as the Stepping Stone diameter of each cluster, that is, the maximum Stepping Stone distance between pairs of points which both belong to the cluster.
- SUR (Digit 12 of IOUTPC) Prints out the fit of a quadric surface to a cluster. This option should not be exercised since the validity of the output is questionable. Clarifying this matter has not been done since it has not had high priority and because the shape and size of a cluster is adequately described by the calculation of cluster axes. The present option has, however, been retained, since it is worth validating.

Output Common To Geometric Analysis of Both Sets and Clusters
(The generic term "group" will be used for "set" or "cluster".)

- BAX (Digit 5 of IOUTPS, Digit 7 of IOUTPC) Prints semiaxes of each group, and the length of each semiaxis.
- PRJ (Digit 6 of IOUTPS, Digit 8 of IOUTPC) Plots for each group the projection of its points on each axis. If the points are represented with coordinates on each axis, the projection is simply the plot of the coordinates for each axis. This provides some visual grasp of how the points are concentrated in the group. The plots are printer plots and quite adequate for their purpose.
- BTR (Digit 7 of IOUTPS, Digit 9 of IOUTPC) Prints transformation to and from bottle axes.
- CGR (Digit 8 of IOUTPS, Digit 10 of IOUTPC) Prints center of gravity of each group. If the group is a cluster, then there is printout as to where the center of gravity is located relative to its cluster.
- COR (Digit 9 of IOUTPS, Digit 11 of IOUTPC) Prints correlation matrix for each group. Also prints the volume of the points in the group as reflected by the determinant, labeled the CVOLUME, as well as the volume of the bottle containing the points. This output is not valid, but its correction has been deferred in favor of higher priority items. The option has not been suppressed since it is conceptually worthwhile and deserves completion.

#### 1.1.3 Logical Sequence

The logical flow in GALACTIC is extremely simple, going directly from beginning to end with no major loops; the only deviation is a section of code in the form of an open subroutine which is executed once for sets from early in the code and is executed again for clusters in the sequence in which it is located.

Accordingly, the artificial format of block diagrams will not be needed. Each section of code will be denoted using statement numbers, since the VAX computers do not use labels for lines. The beginning or end of a section of code will be denoted for example as S580-2 meaning the second line preceding statement labelled 580. The statements are labelled sequentially with few exceptions.

## **Preliminary**

beginning to S110+1	Data Organization
\$110+3	Detect whether batch or time sharing mode
S110+4 to S120-1	Summary data for 891 Annular Cascade Test Points, 16 variables, min, max, average, std dev, mid point, range
\$120 to \$210-1	Print title, date Read names of data files from Annular Cascade Data Base Open temporary data files: 10, 11, 12, 13, 14, 15, 22, 23, 24, 25
S210 to S300-11	Read which variables to be included, any sets or points to be excluded
\$300-10 to \$360+2	Read data files Ol into XINF tables, named variables only Accumulate in VARMOM min, max, sum, sum of squares for each variable Count sets in ISETNAM, points/set in NPINSET Set id per point in IPINSET
S360+3 to S450-1	Print points/set and set id Change id to set number in IPINSET
S450 to S580	Choose option for typical, scale value for each variable
\$580+1 to \$630-1	Read which clusters are bonded, NBOND, IBOND
S630 to 6640-1	Read output codes into IOUTPUT, IOUTPS, IOUTPC If required, go back to do S495-S510+2 to print summary data for each variable
S640 to S740+1	Transform XINF data using typical and scale values, print, save new XINF on file 10
S750 to S809-1	Calculate EDIST matrix of Euclidean distance between pairs of points Save on files 11 and 12 Initialize file 13 to matrix of 1's with 0 on diagonal Point min distance between sets, max distance between points and within sets
S809 to S812+1	Call VERTEX to decide which points have a max or min coordinate

S812 to S790+1 Set parameters for open subroutine (S7075 to S7610+5)

to do basic geometric analysis by set

Initialize "group" to mean "set"

Basic Geometric Analysis (open subroutine; "group" = "sets" or "clusters")

S7075 to S7090+1 Initialization Read data from file 10 into XINF, rearranging by group \$7090 to \$7130 S7130+1 to S7160 Find CG for each group, subtract from data in XINF S7160+1 to S7230-1 Call BOTTLE to find direction and length of axes Count of non zero axes into NAINCL Print diagnostic if dot product of axes exceeds 10<sup>-5</sup> S7230 to S7240-1 Projection of points in group on each axis Transformation to and from axes S7240 to S7320 S7330 to S7340 Go back to 7130+1 for next group, if any S7340+1 to S7350+1 Print out CG of each group If "group" means "set," skip to \$465 S7360 S7360+1 to S7460+1 Read in test points from file O1, adjust for typical and scale values Determine if CG within, outside, toward a cluster S7465 to S7550 Compute correlation matrix VAR for points represented by coordinates on bottle axes S7550+1 to S7610 Compute determinant of VAR matrix, and CVOLUME of group Compute BVOLUME, i.e. volume of box with same axes If "group" means "set," go to S970 \$7610+1 to \$7610+6 If "group" means "cluster," go to \$7615 Discriminant Analysis S970 to S990-1 Use only axes at least 5% as long as first axis Call VERTX to find vertices for each set Restore XINF from file 10 S990 to S9105-1 Initialize axes, axis length and set CG to 0 Subtract CG from XINF data

Call BOTTLE for alldata axes (i.e. irrespective of set) Print axes, length, cg, transformation to and from alldata axes, test points in terms of alldata axes

S990 to S9105-1	Initialize axes, axis length and set CG to O Subtract CG from XINF data Call BOTTLE for alldata axes (i.e. irrespective of set) Print axes, length, cg, transformation to and from alldata axes, test points in terms of alldata axes
S930 to S2080+1	Sort both sets of vertices, combine
S2085 to S2246-1	Determine if points not yet found to be vertices are really vertices or are redundant Exhibit redundant points as linear convex combination of vertices
S2246 to S2250+1	Print for each point its set number, with minus for redundancies
S2260 to S2340	Call INSECT to determine discriminant feasibility (first method), that is if sets are disjoint.  Begin with 1st alldata axis, including successive axes until disjointness occurs or axes exhausted.  If not disjoint, using all axes, exhibit a point as convex linear combination of points in each set.  Do this for all pairs of sets.
S2370 to S2390+2	Copy XINF in alldata axes into file 22
S2400 to S2447+2	Call DISCRM to determine pair of hyperplanes by Relaxed Discriminant method (3rd method) Begin with the number of alldata axes found by INSECT to suffice for disjointness If DISCRM finds these do not suffice, more axes are included If INSECT found sets are disjoint, DISCRM begins with gap case If INSECT found sets are not disjoint, DISCRM begins with overlap case If DISCRM fails, it goes to opposite case using all axes and accepts answer
S2447+3 to S2513+1	Read test points in alldata axes from file 22 Calculate for each point its distance orthogonal to each pair of hyperplanes Mark with E or B if stability condition of point is known and point is on wrong side of a pair of planes or in band
S2517 to S2515+1	Adjust hyperplane to eliminate borderline violations Hyperplane orientation not changed

S2520 to S2510+1	Print set number for each test point, minus if redundant If point is far from planes, on correct side, it is redundant
S3000 to S3064-1	Open Revised Sample file FILINR as file O3 Read name of Population file FILINT Read id of sets or points to be excluded or sets to be combined Invent new name if FILINR already exists
S3064 to S3080-1	Skip if FILINR is blank Read test points from Ol, copy onto O3 unless excluded or redundant
\$3080	Set ISETNAMP equal ISETNAM
S3080+1 to S3320	Skip to S3499 if FILINT is blank Open FILINT as file O2 Read point from FILINT If point is not excluded and has a set not treated in preceding discriminant analysis, copy it onto FILINR Convert point to alldata axes
S3320+1 to S3470+1	Apply hyperplane equations to point Determine for each pair if error, if distance to point along orthogonal to planes is > ,< or between (=) to constants positioning the pair of planes
S3470+2 to S3494+1	If set membership of point is known and a hyperplane is violated, write point onto file 03, tallying type of error Print distance to point in direction orthogonal to planes with mark > , < , = Do for all points on FILINT, file 02
S3495 to S3499-1	Read in name of next population file with new exclusions possible Redo calculations, going back to S3100
S3499	If no more population files, FILINT, rewind 03
S3499 to S3498-1	Print out E totals, if any
S3498 to S3493+2	Print tally of types of error, cases of false identification, number and source of points on revised sample file 03

S4000 to S4060	Transform hyperplane equations to original input variables
S4060+1 to S4067+2	Apply transformed hyperplanes to test points on file Ol, compute distance to point, orthogonal to plane as check against same calculation in alldata axes
S4067+3 to S4121-6	Read in names FILEHI and FILEHO of old and new hyperplane files Open these files as O4 and O7, create new name if necessary for FILEHO
S4121-5 to S4200+5	Read in FILEHI Copy hyperplane from FILEHI onto FILEHO if no new hyperplane was developed for the same pair of sets, or if old hyperplanes same as new Otherwise ask user if in time sharing; use old if in batch Rewind files and close

Clust	ha~ /	l c a l	veic
<u>C103</u>	Le: /	<u> </u>	<u> </u>

<u>Cluster Analysis</u>	
S6000 to S6030-1	Initialization
S6030 to S6200	Calculate SDIST matrix of Stepping Stone distance between each pair of points, IDIST matrix of number of steps between pairs of points and IFRONT matrix of pair of frontier points in going from one point to any other point This makes one sweep through the data Number of changes are counted in ICHANGE2, number of sweeps is counted in ICHANGE1
S6200+1	If ICHANGE2 is 0, go to S6220
S6200+2 to S6210-1	Up ICHANGE1 by 1 Print out ICHANGE2 and computer cost for sweep User decides whether to continue; if yes, go to S6030
S6210 to S6360+1	Delete temporary files no longer needed (12, 13, 14, 15) or (22, 23, 24, 25) Print SDIST, IDIST, IFRONT
S6370-7 to S6550+1	Identify clusters ICLUSTER has point numbers (columns) for each cluster (row)

S6550+2 to S6730+1	Find subclusters
S6730+2 to S6880+3	Combine clusters that are bonded Combine if cluster has only one point
S6890 to S6950	Calculate and print IPINCL, showing for each point the number of its cluster
S6950+1 to S7020	Count points in each cluster, by set
S7020+1 to S7060	Find Stepping Stone distance between clusters Also max Stepping Stone distance within clusters
S7061 to S7075-1	Initialize "group" to mean "cluster" for Basic Geometric Analysis open subroutine Execute open subroutine
S7615 to S7720	Quadratic equation enclosure for each cluster
Termination Procedure	
S9000-2 to S9010	Print computer time used
S9010+1 to S9130+1	If required by user, transform data to alldata axes or axes of some cluster and go to S450
S9140 to S9170-1	If required by user, condense clusters to their CG and go to \$580
S9170 to S9180+1	User decides whether to stop, to go to S130 to begin a new case, or to go to S580 to redo the same case but with possible changes in output or bonding between clusters

#### 1.2 Mathematical Aspects

#### 1.2.1 Matrix Geometric Analysis

In this section several basic geometric questions will be addressed, such as the shape and size of a set of points, the coherence between points and the correlation between variables. This may be termed matrix geometric analysis since the geometric observations are simply interpretations of standard matrix analysis.

The number of test points will be denoted by m and the number of variables per test point will be denoted by n. The data points will be written in an n x m matrix A. Here m may be much bigger than n. Also the number of linearly independent rows in A may be less than either m or n.

#### Normalization of Data Points

In treating test data as geometric points it is helpful to normalize coordinates to have the same range. For example a mach number reading may be 0.9 while a temperature reading may be 900.

To normalize a variable, it is customary to subtract a typical value and then multiply by a scale factor. The typical value might be any measure of central tendency, like the mean, the mid point of the range, etc. The scale factor might be the reciprocal of a measure of dispersion like the standard deviation, the range, etc.

The center of gravity of the set of points is the point each of whose coordinates is the average of that coordinate of the points of the set.

#### Shape of a Set of Points Using Eigenanalysis

A basic geometric question is what sort of shape is formed by these points, what sort of shape would enclose them.

One way to answer this question is to consider all vectors  $y = A^Tx$  where x has unit length  $x^Tx = 1$ . The possible y's consist of all possible linear combinations of the points in A, including in particular the points themselves. The question of which y has maximum length is answered by choosing x so as to maximize  $y^Ty$  subject to the constraint  $x^Tx = 1$ . This written with a Lagrangian multiplier s requires maximization of

$$x^{T}AA^{T}x - s(x^{T}x - 1)$$

which occurs when

$$AA^Tx - s x = 0$$

Thus the x that minimizes y is the eigenvalue of  $AA^T$  with greatest eigenvalue s and the corresponding value of  $y^Ty$  is s.

The successive eigenvectors and eigenvalues give the same answer but in directions orthogonal to the prior y's. If  $x^1$  and  $x^2$  are distinct eigenvectors

$$x^{2T} AA^T x^T = 0$$

and so the y's are also orthogonal

$$y^{2^{\top}}y^{1} = 0$$

The y's thus generated form a set of orthogonal vectors of lengths given by the square root of the corresponding eigenvalues s.

The y vectors thus gotten are themselves eigenvectors of  $A^TA$  since if  $y = A^Tx$  and x is an eigenvector, then

$$A^{T}A y = A^{T}AA^{T}x = sA^{T}x = sy$$

The ellipse satisfied by the y eigenvectors when they have the length  $\left(\frac{1}{s}\right)^{1/2}$  is given by the quadratic equation

$$1 = y^{T}(A^{T}A)^{-1}y$$

If y is an eigenvector of unit length and y is substituted into the quadratic equation the right hand side is  $r^2/s$  so that r must be  $\sqrt{s}$  for the vector to satisfy the equation of the ellipsoid. This says that the ellipsoid contains the y axes as required.

For example if m = 3 and n = 2, consider points (1, 0), (0, 1), (1/2, 1/2). Then

$$A = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1/2 & 1/2 \end{bmatrix} \qquad AA^{T} = \begin{bmatrix} 1 & 0 & 1/2 \\ 0 & 1 & 1/2 \\ 1/2 & 1/2 & 1/2 \end{bmatrix}$$

The eigenvectors and eigenvalues of  $\mathsf{AA}^\mathsf{T}$  are

$$1/\sqrt{3}$$
 ,  $1/\sqrt{3}$  ,  $1/\sqrt{3}$  with eigenvalue  $3/2$   $1/\sqrt{2}$  ,  $1/\sqrt{6}$  ,  $0$  1  $1/\sqrt{6}$  ,  $1/\sqrt{6}$  ,  $-2/\sqrt{6}$  0

Since m exceeds n, the m x m matrix  $AA^{\mathsf{T}}$  is necessarily singular, being of rank at most n.

The corresponding  $y = A^Tx$  vectors are, respectively

$$\sqrt{3/2}$$
 ,  $\sqrt{3/2}$  which is of length  $\sqrt{3/2}$   $\sqrt{2/2}$  ,  $\sqrt{2/2}$  1

which are eigenvectors of  $A^TA = 1/4 \begin{pmatrix} 5 & 1 \\ 1 & 5 \end{pmatrix}$  with eigenvalues 3/2 and 1.

The ellipse with these axes is  $1 = y^{T}(A^{T}A)^{-1}y$ 

$$5 y^2 + 5 y^2 - 2 y_1 y_2 = 6$$

The ellipsoid thus gotten is representative of the shape of the set of points, especially if the original points have been normalized so that each coordinate has a commensurate range, and has been shifted to a central value.

The above development, drawn from classical eigenanalysis provides an ellipsoid which has the shape of the array of data points. When m is a large number, computation of the eigenvalues x can be an imposing task. This is less so for the eigenvalues y since the  $A^TA$  matrix is n x n and much smaller than the  $AA^T$  matrix. Nonetheless eigenanalysis can be difficult.

It is therefore useful to observe that the problem when seen from the viewpoint of matrix norms can be considerably simplified.

The problem of finding the y eigenvectors may be stated as: to find y such that ||Ay|| is maximized while ||y|| is kept constant. Here the vector lengths are stated in the usual Euclidean norm:

$$\|y\| = [y_1^2 + y_2^2 + \dots y_n^2]^{1/2}$$

This approach will be presented next.

#### Ellipsoid as Container

While the ellipsoid as gotten above should reflect the shape of the points represented in A, and contain the axes, it is not clear that all points are necessarily within the ellipsoid. Consider the rectangular box whose axes are those of the ellipsoid.

Any point may be represented as a combination of eigenvectors  $\mathbf{y}^{i}$  of unit length:

$$y = r_1 y^1 + r_2 y^2 + \dots$$

Suppose that a point say  $y^0$  of A were outside the box then  $r_i^2$  exceeds  $s_i$  for some i and  $y^0$ , not  $y^i$  the actual eigenvectors

would have given the maximum of  $y^TAA^Ty$  for components of points orthogonal to the prior eigenvectors. But this is contrary to assumption that  $y^i$  is an eigenvector; it follows that all the points of A are within the rectangular box.

However it is not clear that there may not be points lying inside the box but outside the ellipsoid. Again consider a point  $y^O$  not along an eigenvector to be represented in terms of the eigenvectors  $y^I$  of unit length. For this point not to be an eigenvector it is necessary that when  $x^O$  is chosen (so that  $y^O = A^T x^O$ ) all components are zero but the one corresponding to this point, the result  $y^T y$  is less than  $s_I$ :

$$r_1^2 + r_2^2 + r_3^2 + \dots$$
 < s

Similarly when the same is done for the components of y orthogonal to prior  $\mathbf{y}^{\mathbf{i}}$ 

$$r_2^2 + r_3^2 + \dots$$
 <  $s_2$    
  $r_3^2 + \dots$  <  $s_3$  etc.

When the point y is substituted into the equation of the ellipsoid the result is

$$\frac{r_1^2}{s_1}$$
 +  $\frac{r_2^2}{s_2}$  +  $\frac{r_3^2}{s_3}$  + ...

and the question is how this compares with 1.

The proceeding inequalities may be summed:  $1/s_1$  times the first,  $(1/s_2-1/s_1)$  times the second, $(1/s_3-1/s_2)$ times the third, etc. The result is

$$\frac{r_1^2}{r_1} + \frac{r_2^2}{r_2} + \frac{r_3^2}{r_3} - \dots < n - \frac{s_2}{r_2} - \frac{s_3}{r_3} - \dots$$
 $\frac{s_n}{r_{n-1}}$ 

which lies between 1 and n. The right-hand side can be shown to be less than

$$n - (n-1) \left(\frac{s}{s_1}\right)^{\frac{1}{n-1}}$$

The ratio of the maximum to minimum eigenvalues is one of the measures of the condition of a matrix.

This implies that if the ellipsoid is enlarged so that the unity on the right hand side of its equation is replaced by  $\mathbf{n} - \sum_{s=1}^{s} \mathbf{i} + 1$  then it will enclose the data points. This however may be a less efficient container for the points than the box having the same axes as the ellipsoid.

# Shape of a Set of Points using L<sub>1</sub> Eigenanalysis

An alternate approach is to seek a direction y in which the rows of A have the greatest projection vector. The projection components are the entries in  $p = A_y$ . The projection vector is greatest in the sense that the maximum projection component is greatest for all y's of unit length. The maximum of a vector is a norm, called the  $L_1$  norm so that

$$\|p\|_{1} = \max \left\{ p_{1}, p_{2} \ldots p_{m} \right\}$$

The best y solves the problem:

maximize 
$$\{ \|A_y\|_1 - s(\|y\|_2 - 1) \}$$

where the usual Euclidean norm constrains y to have unit length. (Note that the Euclidean or  $L_2$  norm is the usual vector norm; it is implied when the type of norm is not designated.) Whatever y is found,  $||Ay||_1$  has the form  $a_I^T$  y where  $a_I$  is some row of A. Differentiating with respect to the components of y gives

$$\mathbf{a}_{\mathbf{I}} - 2 \mathbf{s} \mathbf{y} = 0$$

or

$$y = a_{I} / ||a_{I}||_{2}$$

upon imposing the constraint. Thus y is in the direction of some row of A. Consider the projection with row J

$$a_{J}^{T} y = a_{J}^{T} a_{I}^{J} ||a_{I}^{J}|| = ||a_{J}^{J}|| \cos(a_{I}^{J}, a_{J}^{J}) \le ||a_{J}^{J}||$$

Thus the projection is greatest if y is in the direction of the row of A having greatest length.

Having found the first direction  $y^1$  in this way, other directions are sought, each orthogonal to the prior y's. These can be gotten by the same approach, provided the matrix A is altered so as to remove the projections in the direction of the prior y's.

Thus if  $a^{(k)}$  was the latest Jth row of A and  $a^{(k)}$  /  $\|a_{I}^{(k)}\|$  was the latest direction y then the new row would be

$$a_{J}^{(k+1)} = a_{J}^{(k)} - \frac{a_{J}^{(k)} \cdot a_{I}^{(k)}}{\|a_{I}^{(k)}\|_{2}^{2}} a_{I}^{(k)}$$

Note that the problem: find y to maximize

$$\|Ay\|_1$$
 - s( $\|y\|_2$  - 1)

is the eigenvalue problem described previously except that there the Euclidean, or L2, norm  $\|Ay\|_2$  was used, while here the L1 norm is used.

## Axes as New Variables

The axes gotten by  $L_2$  or  $L_1$  eigenanalysis provide a new orthogonal coordinate system which is more natural for the data points than the original coordinate system. This is especially true if the axes are quite short in some direction, indicating a combined variable which is nearly constant for the points in question. If these points are a subset, then it suggests that the subset may be distinguished best from other subsets by the variable which is nearly constant for the subset.

## The Projection Variance and Correlation Matrices

The matrices AA<sup>T</sup> and A<sup>T</sup>A have distinct and useful interpretations in themselves, apart from their usefulness for other purposes.

The matrix  $AA^T$  is an m x m matrix, where m is the number of data points. Its i, j entry is

that is the dot product of the ith data point and the jth data point, or equivalently the projection of one on the other. Thus the diagonal entries of  $AA^T$  contain the Euclidean length of the data points. The matrix  $AA^T$  is therefore the projection matrix.

If the rows and columns of  $AA^T$  are divided by the square root of their diagonal entries, the resulting matrix is composed of the cosine of the angle between pairs of points. To the extent that cosines are near one, the data points are confined to a narrow cone.

The  $A^TA$  matrix is an nxn matrix, where n is the dimension of the space, that is the number of variables that constitute the data point. Its i, j entry is

$$a_{1i}a_{1j} + a_{2i}a_{2j} + \cdots a_{ni}a_{nj}$$

This provides the covariance of the readings of the ith and jth variables according to the formula

cov 
$$(a_i, a_{ij}) = \frac{1}{n} \sum_{k=1}^{n} a_{ki} a_{kj} - \frac{1}{n} \sum_{k=1}^{n} a_{ki} \sum_{k=1}^{n} a_{kj}$$

The last term simply normalizes A by subtracting from each entry, the mean of its column. If this is done first then the i j entry of the resulting  $A^TA$  matrix is n times the covariance of the i and j. normalized data reading.

Thus  $A^TA$  with the indicated normalization is the covariance matrix of the data.

The diagonal entries of the covariance matrix are the variances, that is the standard deviations of the data, squared.

The covariance matrix becomes the correlation matrix if each row and column is divided by the square root of their diagonal entries. The ij entry in the correlation matrix is then the correlation between the readings of the ith and jth variables.

The off diagonal entries lie between +1 and -1 and indicate the degree to which two variables change together (+) or oppositely (-). The main diagonal is of course all ones. To the extent that two variables are correlated, one variable is superfluous.

## Volume of a Set of Points

Another useful piece of geometric information is the volume of the data. In three dimensional space the volume of the parallelepiped having three linearly independent vectors as edges, is given by the determinant of the 3  $\times$  3 matrix having the coordinates of the ith point in the ith row. Similarly for two dimensions.

For n points in n dimensions, the volume of the parallelepiped P is related to the volume of the n dimensional unit cube C by

$$\int_{P} dV = \int_{C} J dV' = J$$

where J is the Jacobian of the linear transformation T that maps the vertices of the cube into those of the parallelepiped. The transformation is required to have the property T  $l^i = x^i$  where  $x^i$  is the ith point written as column vector and  $l^i$  is a column vector having I in the ith position and zeroes in the other n-l positions.

Thus T I = A, which is the n x n matrix whose columns are the vertices of the parallelepipeds. Accordingly the transformation that maps the vertices of the cube into those of the parallelepiped is A x' = x, and its Jacobian is  $J = \det A$ .

This argument can be extended by use of generalized inverses to the general case of m ( $\langle n \rangle$ ) points in n dimensional space, so that for linear independent vertices the volume of the parallelepiped is the square root of the determinant of the m x m matrix  $A^TA$ . This will now be done for the still more general case in which there may be fewer than m linearly independent vectors.

Let the points be represented as columns of the  $n \times m$  matrix A and consider the singular value decomposition, which is available for any matrix. A may be written as

$$A = U Q V^T$$

where U is an nxn matrix of orthonormal vectors, V is an mxm matrix of orthonormal vectors and Q is an nxm matrix whose off diagonal entries are zero. The columns of U are eigenvectors of  $AA^T$ ; while the columns of V are eigenvectors of  $A^TA$ . The diagonal entries of Q are the nonnegative square roots of the eigenvalues. The three matrices are arranged so that eigenvectors and eigenvalues correspond; the non-zero eigenvalues are the same for  $AA^T$  and  $A^TA$ .

A volume may be associated with  $AA^T$  or  $A^TA$  and the square root used as a volume measure for A.

$$\det AA^{\mathsf{T}} = \det(\mathsf{UQQ}^{\mathsf{T}}\mathsf{U}^{\mathsf{T}}) = \det \mathsf{QQ}^{\mathsf{T}}$$

$$\det A^{\mathsf{T}} A = \det (\mathsf{VQ}^{\mathsf{T}} \mathsf{QV}^{\mathsf{T}}) = \det \mathsf{Q}^{\mathsf{T}} \mathsf{Q}$$

since the determinant of an orthonormal matrix is 1 since  $U^{T}U = I$  and  $(\det U)^{2} = 1$ .

The determinant of  $QQ^T$  or  $Q^TQ$  is simply the product of the non zero eigenvalues times any zero diagonal entries. For the volume measure it is convenient to use the smaller of the two matrices.

If for the smaller matrices, there are k non-zero eigenvalues, then we can say that the points are in a k dimensional subspace and within that subspace, the volume measure for the points is the square root of the product of the non zero eigenvalues.

To find the product of the non-zero eigenvalues, it is of course not necessary to calculate all the eigenvalues. Instead it is sufficient to calculate the left right decomposition of, say  $A^TA$ :  $A^TA = LR$ , where L is lower triangular with 1's on the diagonal and R is upper triangular.

Allowing for interchanges, the calculation can restrict any zero diagonal entries in R to the last rows. If there are k non-zero diagonal entries then, we can say that the points are in a k dimensional subspace and that within that subspace the volume measure for the points is the square root of the product of the non-zero diagonal entries in R.

Because of round off, judgment would be needed to recognize when a diagonal entry in R is truly zero. Were this to occur, the calculation of the eigenvalues would be specially useful since the eigenvalues give the individual dimensions of the solid that contains the points. It is equally useful to learn that such a solid is extremely thin in one dimension as to learn that it is of zero thickness.

#### 1.2.2 Convex Hulls

This is the underlying concept for both the linear discrimination between sets of test points having different stability conditions, as well as the recognition of irrelevant test points.

Intuitively, the convex hull of a finite set of points is the smallest solid with polygonal faces and no reentrant corners that contains all the points. Evidently the vertices of the solid are all members of the set of points.

This concept is of great importance for identification of regions with the same stability condition since it gives mathematical meaning to the belief that the points with common stability condition define a region within which the same stability condition prevails.

Also if test points from two different stability regions are close together, and are difficult to distinguish, the mathematical interpretation can be that the convex hulls of the two regions intersect.

Thus the mathematical concept of convex hulls appears to capture precisely the intuitive meaning of a stability region. However the convex hull is a minimal stability region, whereas the intuitive stability region might be thought to extend to some indefinite distance beyond the test points known to be in the region.

The mathematical definition of a convex hull of a set of points S is the smallest convex set that contains S. A convex set is a set which contains the point  $x = a_1 x^1 + a_2 x^2$  where  $a_1 + a_2 = 1$ , provided the points  $x^1$  and  $x^2$  are in the set. This says simply that the line segment between every pair of points in the set is also in the set. Thus a donut with a hole is not a convex set, while a donut without a hole is.

Here superscipts denote different points, while subscripts as .n

$$x = (x_1, x_2, .... x_n)$$

denote the coordinates, the space being n dimensional.

A hyperplane is the locus of points x such that an equation like

$$c = a_1 x_1 + a_2 x_2 + ... a_n x_n$$

holds. This may be written simply as  $c = a^Tx$  using vector notation. For other points the right-hand side exceeds c, indicating that those points are in the half space on one side of the hyperplane. For still other points, the right-hand side falls short of c, indicating that those points are in the half space on the other side of the half space.

A hyperplane, defined by a vector a and a scalar c, is said to be a supporting hyperplane of a set if

$$c \leq a^T x$$

holds for all points x of the set, with equality holding in some cases. Thus the set is entirely on one side of the hyperplane, with some points of the set belonging to the hyperplane.

Boundary points of the set may be defined as those points of the set which are in some supporting hyperplane.

A vertex is a member  $\mathbf{x}^{\mathbf{O}}$  of the set which cannot be represented as a convex linear combination, such as

$$x^0 = a_1 x^1 + a_2 x^2$$
;  $1 = a_1 + a_2$ ;  $0 < a_1, a_2 < 1$ 

for any other points  $x^1$ ,  $x^2$  of the set.

An interior point  $\mathbf{x}^{\mathbf{O}}$  of the set is a point which may be represented in many ways as a convex linear combination

$$x^0 = a_1x^1 + a_2x^2$$
;  $1 = a_1 + a_2$ ;  $0 < a_1, a_2 < 1$ 

of points of the set, with  $\mathbf{x}^1$  being any vertex of the set. Thus a line through the point from any vertex has points of the set on both sides of the point in question.

A vertex cannot be an interior point since its own representation on a line through it must leave one coefficient  $a_1 = 1$  and the other  $a_2 = 0$ .

A vertex must be one of the original defining points of the convex hull since it cannot be generated from other points using convex linear combinations.

A supporting hyperplane must contain some of the original defining points since the points of a convex hull which are in a supporting hyperplane can be generated only as intermediate points of lines within the plane, not of lines that pierce the plane, since there are no points on one side of the plane.

An easy criterion to identify at least some of the vertex points in a set is that any point with a coordinate greater, or less than that coordinate of any other point is a vertex. Otherwise the point would be an interior point x with a convex linear representation

$$x = a_1 x^1 + a_2 x^2 + \dots + a_m x^m$$

in terms of other points of the set. But then

$$x_k = \sum_{i=1}^{n} x_k^i \ge \max_{i} x_k^i \sum_{i=1}^{n} \max_{i} x_k^i$$

which cannot be since by hypothesis  $\mathbf{x}_k$  exceeds  $\mathbf{x}_k^i$  for any i. Similarly for least coordinates.

In case several points have the same maximum coordinate, say  $x_k = d$  then they belong to a supporting hyperplane  $x_k = d$  and among these, those having some maximum or minimum coordinate are all vertices.

Indeed we may see any vertex with extreme coordinate as a point in a supporting hyperplane.

It is easy to see that linear transformations, of stretching, translation or rotation map straight line segments into straight line segments, so that topological properties such as a point being a vertex, an interior point, or in a supporting hyperplane are all preserved. Such transformations can, however alter which point has an extreme coordinate and could in fact produce all the vertices.

Note that there can be at least 2<sup>n</sup> vertices with a maximum or minimum coordinate. Thus in higher dimensional space, a smaller proportion of points in a set are likely to be interior points.

Simplicial coordinates for an n dimensional space are defined in terms of n+1 points  $x^1$ ,  $x^2$ , ...  $x^{n+1}$ . An arbitrary point x has simplicial coordinates  $a_1$ ,  $a_2$ , ...  $a_{n+1}$  means that

$$x = a_1 x^1 + a_2 x^2 + \dots + a_{n+1} x^{n+1}$$

and 1 = 
$$a_1 + a_2 + ... a_{n+1}$$

To determine the simplicial coordinates, it is necessary to solve the  $(n + 1) \times (n + 1)$  linear system

$$X^{T} a = x$$
 $1^{T} a = 1$ 

where  $x^i$  in rectangular coordinates occupies the ith row of X. The set is solvable if the  $(n + 1) \times (n + 1)$  matrix  $(X^T)$  is not singular, that is if the n + 1 vectors  $x^i$  are not coplanar, that is no vector b and scalar d can be found so that  $x^Tb = d$  can be satisfied by all n+1 vectors.

In two dimensions the three points are the vertices of a triangle. The sides of the triangle, extended divide the space outside the triangle into 6 regions. Inside the triangle  $a_1$ ,  $a_2$ ,  $a_3$  are positive. Upon crossing each side, one of the coordinates turns negative. Upon leaving the triangle through a vertex, two coordinates turn negative. Since the  $a_i$  add to 1, there can be no region wherein all simplicial coordinates are

negative. The indication that a point is a boundary point is that some simplicial coordinate is 0. It is of course a vertex if all simplicial coordinates are 0, except one.

Any point of the convex hull of a set of points  $x^1$ ,  $x^2$ , ... $x^m$  can be expressed as a convex linear combination

$$x = a_1 x^1 + a_2 x^2 + \dots + a_m x^m$$

where  $1 = a_1 + a_2 + \dots a_m$ 

and 
$$0 \le a_i \le 1$$
 for  $i = 1, 2, ...m$ 

This is true of points generated as linear combinations of some two of the original points. Subsequently if this is true of two points x', x'' then, it is true of a convex linear combination of them

$$x = a'x'+a'' x'''$$
  
=  $a'(a'_1x_1+a_2' x_2+...)+a'' (a'_1 x_1+a''_2 x_2+...)$ 

= 
$$(a'a'_{1}+a''a''_{1})x_{1}+(a'a'_{2}+a''a''_{2})x_{2}+\cdots$$

since 
$$\sum (a'a' + a'' a''_i) = a' + a'' = 1$$

and 
$$a'a'_1 + a''a''_1 \stackrel{>}{\Rightarrow} 0$$

and therefore 
$$a'a''_1 + a''a''_1 \leq 0$$

A hyperplane  $c = x^T a$  in dimensional space can be defined to contain linearly independent points say  $x^1$ ,  $x^2$ ,... $x^n$ . If the n coordinates of these points are written as the rows of an n x n matrix X then

Xa = 1

where I denotes a column vector of all I's. Once a is found it is frequently desirable to replace a by the unit vector a/ .|| a || with I/ ||a|| written as the right hand side.

If the points are not linearly independent then the matrix X is non-singular. A plane that is to one side of m points where m may be greater or less than the dimension n of the space, can be expressed as

 $Xa \leq c$ 

Similarly a plane that discriminates between a set of points whose coordinates are the rows of X and another set of points whose coordinates are the rows of Y, can be expressed as

 $Xa \leq c \leq Ya$ 

These ideas will be developed further in the discussion of discriminant analysis. They will there be used to discriminate between the test data points exhibiting one stability condition, and those exhibiting a different stability condition.

A different use of these concepts is the identification of redundant points, that is test data points which are in the interior of the convex hull defined by other test data points. Such points are of no use in defining where one stability region ends and another begins. They may therefore be discarded thus reducing the size of the relevant data base.

An interior point x may be expressed as

$$x = X^{\mathsf{T}} a$$

$$1 = 1^{\mathsf{T}} a$$

$$0 \le a_{\dagger} \le 1$$

where the X matrix consists of the other data points, written as rows. The data points already known to be redundant may be omitted from X.

This is a linear programming problem, without objective function, that is it is the feasibility problem. It can be solved in the usual way by introducing an artificial objective function representing the violations of the constraints. If this objective function can be reduced to zero then the problem is feasible. Such a device is quite reasonable and economical if upon establishment of feasibility, an authentic objective function is then pursued by the mechanism already in place.

However the artificial objective function is less attractive when feasibility is the only question to be answered. Thus it seemed useful to modify the usual simplex algorithm so as to bypass use of an objective function.

A further compelling reason for doing this is to accommodate the coding to the special situation here, where a test point x once found to be non-redundant would need to be considered for the basis used in evaluating subsequent test points for redundancy.

To take advantage of these two aspects of this particular application, a special modification of the simplex algorithm has been developed. It has been named the "Non-Objective Simplex Method."

## 1.2.3 The Non-Objective Simplex Method

The problem addressed is feasibility of the linear programming problem: find x such that

$$Ax = b \qquad x \stackrel{\triangle}{=} 0$$

where A is an m x n matrix where m < n, x is a vector of n entries and b has m entries. Feasibility asks whether there are any x vectors meeting these requirements.

The objective function which might accompany this problem is not relevant to the feasibility question. However it is usual to introduce an artificial objective function and artificial variables so that the augmented problem is trivially feasible and if its (artificial) objective function can be driven sufficiently large, feasibility of the original problem will have been established.

There are two disadvantages of the usual approach. It enlarges the matrix A and feasibility is only obliquely addressed and therefore perhaps inefficiently. Its advantage is that the code designed to solve the linear programming problem with objective function is also used for the prior task by finding a feasible starting point. But this is no advantage if only feasibility need be shown.

Thus it is believed that the approach to be described may prove more efficient for the case in which the question of feasibility is the only task.

Since this development was done separately from other work being reported on, the notation is somewhat different.

The columns of A will be denoted as  $a^1$ ,  $a^2$ , ...  $a^n$ . A will be assumed to be of full rank m. The vector x is a set of coefficients for the columns of A, expressing b as a linear combination of the columns of A. Since any vector can be expressed in terms of only m columns of A,

it will be assumed that only m components of x are non-zero. Feasibility is established if an x is found having no negative coefficients. The feasible solution will be found by generating a sequence of non-feasible solutions  $x^1$ ,  $x^2$ ,...which hopefully will have fewer and fewer negative coefficients.

Initially  $x^1$  is gotten by picking m linearly independent columns of A, and solving for the linear combination  $x^1$  by which they represent b. Denote by  $n_1$  the number of negative coefficients in  $x^1$ . The next goal is to find an  $x^2$  which will have fewer negative coefficients.

To do this, it is convenient to represent all the columns of A as linear combinations of the basis columns. These representations are collected in a matrix E, whose ij entry is the coefficient of the ith basis vector in the representation of the jth column of A. If the jth column is a member of the basis, say the kth member, then column j of E is all zeros except that  $\mathbf{e}_{kj}$  is 1. This matrix E is essentially the "tableau" spoken of in linear programming literature.

Thus if B consists of the m columns of A which constitute the basis then

$$E = B^{-1}A$$
  $X^1 = B^{-1}b$ 

so that the columns of A in the basis become columns of the identity in E.

# Choice of Advantageous Change to Basis

Consider what advantage there might be in replacing some member of the basis used in  $\mathbf{x}^1$  by column  $\mathbf{k}$  of  $\mathbf{A}$ .

If the basis consists of columns numbered  $c_1, c_2,...c_m$  of A then

$$a^k = \sum_{i \in A} a^{c_i}$$

and is represented in E by  $[e_{1k}, e_{2k}, \ldots]^T$  as the kth column. The representation of b using  $x^1$  is

$$b = \sum_{i=1}^{m} x_i a$$

but is also trivially equal, for any multiplier r, to

$$b = \sum_{i=1}^{m} x_{i} = -r \sum_{i=1}^{m} e_{i} = x_{i} + r_{i}$$

$$= \sum_{i=1}^{m} x_{i} = -r \sum_{i=1}^{m} e_{i} = x_{i} + r_{i}$$

$$= \sum_{i=1}^{m} (x_{i} - r_{i}) = x_{i} + r_{i}$$

To represent b in terms of a basis containing  $a^k$  in place of  $a^{cj}$ , all that is needed is to set

assuming that  $e_{jk} \neq 0$ . The fact that  $e_{jk}$  is not 0 assures that the new basis would still have no more than m linearly independent members.

Since the coefficients in  $x^2$  are  $x_i^{-1}$  -  $re_{ik}$  and r it is easy to count how many are negative and therefore whether introduction of column k into the basis can be advantageous.

If 
$$e_{ik} > 0$$
 and  $r < x_i^{-1}/e_{ik}$  then  $x_i^{-2} > 0$ 

If 
$$e_{ik} < 0$$
 and  $x_i/e_{ik} \le r$  then  $x_i^2 \ge 0$ 

If 
$$e_{ik} = 0$$
 then  $x^2 = x^1$ 

Since if  $r \stackrel{>}{=} 0$  then  $x_k^2 \stackrel{>}{=} 0$  the lower bounds on r should also include 0.

Denote the least and greatest of the lower bounds on r, (including 0) by  $r_1$  and  $r_2$ , respectively; denote the least and greatest of the upper bounds by  $r_3$  and  $r_4$ , respectively. By their definition

$$r_1 \leq r_2$$
 and  $r_3 \leq r_4$ 

If  $r_2 \leq r_3$  then all bounds on r will be satisfied if k displaces either the basis vector determining  $r_2$  or that determining  $r_3$ . The number of negative coefficients in  $x^2$  would then be

$$n^2$$
 (k,r) = number of  $x_i^{-1} < 0$  for which  $e_{ik} = 0$ 

If  $r_1 < r_3 < r_2 < r_4$ , then some bounds on r are violated and r is best chosen in the interval

$$r_3 < r < r_2$$

since choice of r outside this interval would violate upper or lower bounds without a compensating satisfaction of lower or upper bounds.

If  $r_3 < r_1 < r_2 < r_4$  or  $r_1 < r_3 < r_4 < r_2$ , r should again be chosen in the interval

$$r_3 \leq r \leq r_2$$

as there is only disadvantage outside this interval.

If  $r_3 < r_1 < r_4 < r_2$  or  $r_3 < r_4 < r_1 < r_2$ , r is again to be chosen in the interval

$$r_3 \leq r \leq r_2$$

which here says to examine all possibilities.

Thus in all cases r is to be chosen in the closed interval extending between  $r_2$  and  $r_3$ . It is in general necessary to search for all bounds in the interval to see how many are violated. The only values of r to be evaluated are the values equal to a bound. Then

n(k,r) = [number of upper or lower bounds which are violated] + [number of  $x_i^{-1} < 0$  for which  $e_{ik} = 0$ ] This procedure is done for all k, or at least until an  $n^2$  is found which is less than  $n^1$ .

If at the best value of r, there is only one bound, say for the basis vector number  $\mathbf{c_p}$ , which is column, say h, of A, then column  $\mathbf{a^k}$  of A replaces column  $\mathbf{a^h}$  in the basis and the  $\mathbf{c_p}$  th basis vector becomes column  $\mathbf{a^k}$ , rather than column  $\mathbf{a^h}$ .

In case several bounds are simultaneously satisfied at the best value of r, k replaces only one of them in the basis - which one may be chosen arbitrarily. Thus the basis still has m linearly independent vectors even though b can be expressed with fewer.

## Updating x and E

It is clear from the foregoing how  $x^2$  is computed from  $x^1$ 

$$x_i^2 = x_i^1 - re_{ik}$$
 for  $i \neq p$ 

$$x_p^2 = 0$$

Also E used for the basis associated with  $x^1$ , which can be labeled  $E^1$ , can be easily updated to the matrix  $E^2$  associated with the basis associated with  $x^2$ .

Column  $a^{\dagger}$  of A was represented by the jth column of  $E^{\dagger}$ :

In particular

$$a^{k} = \sum_{i=1}^{m} e \quad a^{ci}$$

which implies

cp m ci k
a = 
$$-\sum_{i=1}^{m} e_i / e_i$$
 a + 1/e a
i=1 ik pk pk
i#p

where  $\mathbf{e}_{\mathbf{k}}$  was not 0 since the basis vector  $\mathbf{c}_{\mathbf{p}}$  replaced by column k was a bound for r and so had its  $\mathbf{e}_{\mathbf{pk}}$  non zero.

Replacing a<sup>c</sup>! in the equation for a<sup>j</sup>, gives

Thus

Note that this implies that column k of  $E^2$  is all 0, except for  $e_{pk}^2$  which is 1.

Also whereas in  $E^1$  column h had been all 0 except for  $e_{pk}^{-1}$  which was 1, in  $E^2$  this column becomes, according to the above formula

2 1 1 
$$e = -e$$
 /e for  $i \neq p$   $ik$   $pk$ 

and

$$e_{ph}^{2} = 1/e_{pk}^{1}$$

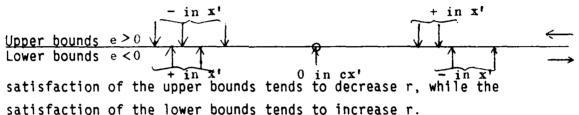
Other columns, say column q, which are in both the basis associated with  $x^1$ , as well as the basis associated with  $x^2$  retain their form — all 0 except for a single 1 — since  $e_{iq}^{I}$  was 0 in  $E^{I}$  being the coefficient of  $a^{Cp}$  in the representation of  $a^{q}$  which was also in the basis. Thus  $e_{iq}^{I} = e_{iq}^{I}$ .

We see therefore that all E matrices contain an mxm identity matrix, in permuted form. By recording which columns of A correspond to which columns of the remaining columns of E, as well as which correspond to the rows of E, it is possible to omit storage of the mxm identity.

The procedure will have found a feasible point once all coefficients of x have been made non negative, i.e. once  $n_i$  has become 0.

#### Further Discussion of Change to Bases

It is easy to observe schematically what difficulties can arise in the choice of r, by use of the following schematic. A line representing values of r ranging from negative to positive values is marked on the upper side with arrows at the upper bounds on r, and on the lower side with arrows at the lower bounds on r. The



The last point  $x^1$  is represented by r = 0, where the lower bound on the new column k is located.

If r is increased from 0 and the first bound it encounters is a lower bound then that choice of r eliminates a negative coefficient and includes a new positive coefficient, leaving other coefficients of x unchanged in sign.  $\uparrow$ 

If however the first bound was in upper bound, that choice of r represents no net change in the types of coefficients of x, i.e. +, 0, -.

If r was decreased and the first bound encountered, other then that at 0, was an upper bound, that choice of r represents no net change in the type of coefficient.

If r was decreased and the first bound encountered, other than at 0, was a lower bound, that choice of r represents a switch of a + coefficient to a - coefficient.

Thus the simple strategy of choosing r at an upper or lower bound nearest r = 0, which represents  $x^1$ , increases the + coefficients in  $x^2$  over those in  $x^1$  only if r is increased and the first bound encountered is a lower bound.

It is of course a less complex procedure simply to search the full range of bounds on r.

As to which k column is most advantageous for inclusion, one criterion is to choose at least initially the column in E which has most uniformity in sign, since then most bounds in O are either upper or lower bounds, and can easily be satisfied en masse.

## Program Flow

- o Choose basis among vectors with extreme values max, min of any component.
- o Form triangular decomposition, modifying choice of vectors as decomposition proceeds.
- o Record basis names in vector IR.
- o Apply triangular factors to columns of A not in basis. Form matrix E. Keep running count of sign diversity. Put vectors with extreme value first. Record column number of non basic vectors in vector IC.
- o If all entries in column have same sign + record for inclusion. If all entries have sign then a feasible point has been found.

- o Apply factors to b to get  $x^{1}$ . Record number of minus signs in n.
- o Update E, x, IR, IC. Repeat preceeding step.
- o Calculate for each k

lower and upper bounds,  $0_1$ ,  $0_2$ ,  $0_3$ ,  $0_4$  pick the 0 with the maximum advantage

Quit if all x 0.

- o Calculate for each k: lower and upper bounds  $r_1$ ,  $r_2$ ,  $r_3$ ,  $r_4$ . Pick the r with the maximum advantage.
- o Update E, x, IR, IC. Repeat preceding step.
- o Quit if all x non-negative.

#### 1.2.4 Discriminant Analysis

The task addressed by discriminant analysis is to find a surface that separates two sets of points. If the coordinates of a point are substituted into the mathematical equation of the surface:  $f(x_1, x_2, ...) = C$  the point is on one side of the surface if the result exceeds C, is on the other side if the result falls short of C and is exactly on the surface if the result equals C. The surface is said to discriminate between the two sets of points.

The simplest type of surface is the plane, or as is sometimes said for higher dimensional space, the hyperplane. The equation for a plane is of the form:  $\sum a_i x_i = C$ , that is, it is a linear function of the  $x_i$  as well as a linear function of the coefficients  $a_i$ .

It is possible to devise methods for nonlinear expressions. For example, the ellipse in two dimensions has the form:  $a_1x_1^2 + a_2x_2^2 = C$ . However, the methods for linear expressions can address this problem by considering the expression as linear in the transformed variables  $x_1^2$  and  $x_2^2$ .

This device cannot treat expressions in which the unknown coefficients do not appear linearly; such as  $a_1x_1 \xrightarrow{a_2} +a_3x_2 \xrightarrow{a_4} = C$  or  $a_1 \sin(a_2x_1) + a_3 \sin(a_4x_2) = C$ .

Discriminant analysis can be viewed as geometric or as probabalistic. The geometric view is expressed above. The probabalistic view seeks a surface which discriminates with a high confidence. It can address situations in which the sets of points substantially interpenetrate one another.

For the flutter prediction problem, it is believed that linear, geometric discriminant analysis is the basic tool and that it will prove adequate, especially when enhanced with nonlinear combination variables. Any interpenetration of stability regions is believed attributable to imprecision of measurement or to higher order effects not modeled here. In either case, the degree of interpenetration is expected to be small.

The empirical flutter prediction problem is directly addressed by discriminant analysis. The Annular Cascade Data Base consists of a large number of test points each identified as being in one out of fourteen possible stability regions. Taking these regions two at a time, it is desired to find a plane that separates each region from the other. To conclude that a test point is in a stability region, it would, ideally, need to be on the side of each of the thirteen planes that discriminated that stability region.

GALACTIC contains two linear, geometric discriminant analysis methods. Both utilize linear programming.

The first method addresses the easier question: whether there is a discriminating plane. This question can be answered without actually exhibiting the plane. The second method addresses the more difficult problem of finding the plane. The first method will be called the Discriminant Feasibility method.

The first method is valuable because it can identify the smallest number of variables for which the sets are separable. The first method is quick and robust. The second method which is more costly and less robust can therefore avoid unprofitable exploration of small subspaces.

The second method has been modified to become a third method, called the Relaxed Discriminant method. It seeks to find a pair of parallel planes that discriminate the stability regions. Between the planes there is either a gap or an overlap. Thus the third method should provide an approximate solution even when the regions are not truly separable.

Consider that there are two sets of points in m dimensional space, one with  $n_1$  points and the other with  $n_2$  points. These points can be represented respectively as the rows of an  $n_1$ \*m matrix  $X_1$  and the rows of an  $n_2$ \*m matrix  $X_2$ .

## Discriminant Feasibility Method

The first method will simply determine whether the two sets of points intersect, in the sense that their convex hulls intersect. In two dimensions the convex hull is the smallest polygonal region that contains all the points and has no reentrant corners. Algebraically a point z is in the convex hull of the  $n_1$  points in  $X_1$  if z can be represented as a linear combination of the rows of  $X_1$ 

$$z = aX_1$$
  $a_1 \stackrel{\triangle}{=} 0$ 

where a is a row vector whose components are non negative and which add to 1

$$\sum_{i=1}^{n} a_i = 1$$

Now z is in both sets if there is also a row vector b such that

$$Z = b X_2$$

$$\sum_{i=1}^{n_2} b_i = 1 \qquad b_i \stackrel{>}{=} 0$$

The problem of determining whether there are points z which are in both convex hulls may be converted to a standard linear programming problem as follows. Equate the two expressions for z:

$$aX_1 - bX_2 = 0$$

or

$$\begin{pmatrix} a & b \end{pmatrix} \begin{pmatrix} x_1 \\ -x_2 \end{pmatrix} = 0$$

The  $\sum a_i = 1$  and  $\sum b_i = 1$  requirements can be incorporated

(a b) 
$$\begin{pmatrix} X_1 & 1 & 0 \\ & 1 & 0 \\ & & 1 \\ & & 1 \\ & & - & \frac{1}{10} - & \frac{1}{10} \\ & & & 1 \end{pmatrix}$$
 (0... 11)

Combining a and b into y = (a,b), this equation becomes

$$\begin{pmatrix}
T & T \\
X_1 & -X_2 \\
\vdots & \vdots & \ddots & \vdots \\
11... & 00... \\
00... & 11...
\end{pmatrix}$$
 $y = \begin{pmatrix} 0 \\ 0 \\ \vdots \\ 1 \\ 1 \end{pmatrix}$ ;  $y = 0$ 

Thus it is required to find an n entry non-negative column vector y which satisfies the above m+2 equality constraints.

The objective function is of secondary importance since the basic question here is whether there is a feasible solution, that is, whether the two convex hulls intersect. If they do, then the two sets cannot be discriminated linearly.

Since linear programming codes generally require an objective function  $C_i y_i$ , it is convenient to pick the  $C_i$  so as to emphasize the role of certain points in  $X_1$  or  $X_2$ .

However, the easy choice of making the  $C_i$  for  $X_l$  equal, and those for  $X_2$  equal is not advisable since in view of the constraints  $\sum a_i = 1, \sum b_i = 1$ , such an objective function would reduce to  $C_l + C_{nl+1}$  which is constant. While inconsequential for the feasibility question, a constant might inadvertently cause programming problems.

Thus to conclude that two sets cannot be linearly discriminated, it is sufficient to show that a certain linear programming problem is feasible. Conversely, if the linear programming problem is not feasible, then the convex hulls of the two sets do not intersect and it is therefore possible

to find a plane that lies between them, intersecting neither set. The plane is used to discriminate between the two sets. Note that this method does not produce such a discriminating plane.

## Determination of the Discriminating Plane

The second method is more complicated, but it accomplishes more. It identifies a discriminating plane, that is, a plane that separates two non-intersecting sets.

Any point x that satisfies xp = d is on a plane having column vector p and perpendicular from the origin and situated a distance d/  $||p||^2$  from the origin.

Such a plane would discriminate the sets in  $\mathbf{X}_1$  and  $\mathbf{X}_2$  if

$$X_1 p \stackrel{\Delta}{=} d$$

$$X_2 p \leq d$$

or equivalents,

$$\begin{bmatrix}
 X_1 & & & & \\
 & & & -1 \\
 & & & -1 \\
 & & & \vdots \\
 & & & -1 \\
 & & & \vdots \\
 & & & -1 \\
 & & & \vdots \\
 & & & +1 \\
 & & & +1 \\
 & & & \vdots
 \end{bmatrix}$$

or abbreviating

$$z \neq 0$$

where Z is  $n^*(m+1)$ , n being  $n_1+n_2$ , and q is an m+1 vector.

A few comments are appropriate.

There is no inequality constraint on the components of p or on d; hence it is no restriction to choose that  $X_1p$  exceed d and for  $X_2p$  to be less than d, rather than vice versa.

The problem as stated allows the two sets, and therefore the discriminating plane, to have common boundary points. This could be prohibited by requiring

$$X_1 p \stackrel{\checkmark}{=} d_1 ; \quad X_2 p \stackrel{\checkmark}{=} d_2; \quad d_1 - d_2 \stackrel{\checkmark}{=} k$$

or Z q≥t

for some chosen  $k \ge 0$ . Z would have one extra column as well as an extra row for the  $d_1-d_2$  k constant. If alternatively k were allowed to be slightly negative, then some overlap between the two sets would be allowed.

While the problem statement involves linear inequalities, it is not in standard linear programming format since there are no inequalities constraining q. The following converts the problem to standard format.

Write 
$$Zq = t$$
  $t \stackrel{\triangle}{=} 0$ 

and utilize the so called generalized inverse  $Z^+$  for Z

$$q = Z^+ t$$
.

# <u>Digression on Generalized Inverses</u>

A digression about generalized inverses is appropriate here. First it will be explained how best to compute the generalized inverse, and then what is its usefulness.

The best way to compute  $Z^+$  is to compute the singular value decomposition of Z. This is a representation of the  $n \times m$  matrix Z as the product

$$z = u \circ v^{T}$$

where U is n\*n and orthogonal  $(U^{T}=U^{-1})$ , V is m x m and orthogonal  $(v^T = v^{-1})$  and Q is an n<sup>\*</sup>m matrix which is zero except for the diagonal terms which may or may not be 0. The generalized inverse  $Q^+$  of Q is defined as the m x n matrix which is zero except possibly for the diagonal entries. The ii entry is 0 if  $q_{ij} = 0$  and is  $1/q_{ij}$  if  $q_{ij} \neq 0$ .

Thus  $I_Q = Q Q^{\dagger}$  is an n x n matrix which is zero except that its ii diagonal entry is 1 when  $q_{ij}\neq 0$ .

Now the generalized inverse of Z is

$$Z^+ = V Q^+ U^T$$

As a result.

$$ZZ^+ = U Q V^T V Q^+ U^T$$

$$U Q Q^+ U^T$$

$$UI_0U^T$$

If for instance it were square and non-singular, then Q would have no zeroes on its diagonal and accordingly  $I_0$  would also not have zeroes on its diagonal so that  $ZZ^+ = UIU^\top = I$  and  $Z^+$  is the (usual) inverse  $Z^{-1}$ .

If Zq = t represented a least squares problem in which  $n \ge m$  and Z had rank m, then the usual solution is

$$q = (Z^+Z)^{-1} Z^Tt$$

which is

= 
$$(VQ^TU^TUQV^T)^{-1} VQ^TU^Tt$$

$$= (v0^{T}0v^{T})^{-1} v0^{T}u^{T}t$$

= 
$$(VQ^{T}QV^{T})^{-1} VQ^{T}U^{T}t$$
  
=  $(V^{T})^{-1} (Q^{T}Q)^{-1} V^{-1} VQ^{T}U^{T}t$   
=  $V (Q^{T}Q)^{-1} Q^{T}U^{T}t$ 

But since Z had rank m, then Q could not have zeroes on its diagonal,  $Q^TQ$  is an m x m non-singular diagonal matrix and  $(Q^TQ)^{-1}Q^T = Q^+$ . Thus the usual least squares solution is also the generalized inverse

$$q = VQ^+U^Tt$$

Other situations which have been treated in traditional ways could also be presented as persuasive of the reasonability and practicality of the stated generalized inverse. However, it is perhaps more useful now to give the following derivation.

Since any matrix whether square or rectangular, singular or non-singular, has a singular value decomposition, the problem Zq = t can be written equivalently as

$$UQV^{T}q = t$$

or

$$QV^Tq = U^Tt$$

or

$$Qr = s$$

where  $s = U^T t$  and q can be gotten from r by

q = Vr

The equation Qr = s, spelled out is simply

$$q_{11}r_1 = s_1$$

If  $q_{ij} \neq 0$ , then  $r_i = s_i/q_{ij}$ . But if  $q_{ij} = 0$  then  $r_i$  is arbitrary. According to the generalized inverse defined above,  $r_i$  is set to 0 when  $q_{ij} = 0$ . This says that

$$r = Q^{\dagger}s$$

But then

q = Vr

- $= VQ^+s$
- = VQ+UTt

which is the formula presented above.

## Determination of the Discriminating Plane (continued)

For the discrimination question, it is necessary to ask when the generalized inverse is an exact solution. This is the case provided that Zq equals t, that is, provided  $ZZ^{+}t = t$  or

$$[Z(VQ^{\dagger}U^{T}) -I] t = 0$$
  
 $[UQV^{T}VQ^{\dagger}U^{T} -I] t = 0$   
 $[UQQ^{\dagger}U^{T} -I] t = 0$ 

Here QQ<sup>+</sup> is an n x n diagonal matrix, say D whose ii entry is 1 if  $q_{ii} \neq 0$  and 0 if  $q_{ij} = 0$ . Thus the above may be written

$$[UDU^{T} - I] t = 0$$

or

$$[U(D-I)U^{T}] t = 0$$

or

$$UI_1 U^T t = 0$$

Since U is non-singular, this may be written simply as

$$I_1 U^T t = 0$$

where  $I_1$  is an n\*m diagonal matrix whose ii entry is 0 if  $q_{ij} \neq 0$  and +1 if  $q_{ij} = 0$ . This is the necessary and sufficient condition that

$$q = VQ^+U^Tt$$

is an exact solution for Zq = t. This might seem to be a virtually impossible condition to meet. Indeed when Z is rectangular and of rank less than m, as in a least square problem, it is not likely that q can be found which will exactly satisfy Zq = t for a preassigned t.

But here the t is not preassigned; any t with non-negative components will do. Indeed t is simply an eigenvector of  $UI_1U^T$  which corresponds to a 0 eigenvalue. The necessary and sufficient condition  $UI_1U^Tt = 0$  can be simplified to

$$I_1UTt = 0$$

since U is square and non-singular.

For the discriminant analysis task at hand, finding a q such that Zq is non-negative is seemingly effortlessly satisfied by choosing a non-negative t (that satisfies any other constraints) and calculating

$$q = Z^{+}t$$

provided that this implies Zq = t. This implication is valid if

$$ZZ^{+}t = t$$

which is developed above.

The problem of finding a discriminating plane between two sets has thus been reduced to the following linear programming problem in standard format: find t such that

$$I_{\uparrow} U^{\uparrow} t = 0 \qquad t \ge 0$$

This is a system of at least n-m equations in n unknowns:  $t_1$ ,  $t_2$ , ...  $t_n$ .

The solution of the system of equations can actually be expressed as

$$t = UI_2c$$

where c is arbitrary and  $I_2 = I - I_1$  which is D defined above. To show this, substitution gives

$$I_1 U^T U I_2 c = I_1 (I - I_1) c = 0$$

Thus t is a linear combination of the rows of  $\mathbf{U}^\mathsf{T}$  which are not in the system  $\mathbf{I}_1\mathbf{U}^\mathsf{T}\mathbf{t} = \mathbf{o}$ .

Clearly then the constraint  $I_1U^Tt = 0$  describes an unbounded region. If any vector in this region satisfies  $t \triangleq 0$ , an arbitrarily large multiple of the vector also is feasible. Thus the feasibility region if it exists is unbounded.

The linear programming problem thus posed has a finite solution only if the objective function seeks small rather than large feasible points. But seeking small feasible points leads to the origin which is clearly a feasible point. Thus the linear programming problem leads to either ill defined infinite solutions or the trivial solution.

To avoid the dilemma, a constraint

$$\sum t_i = 1$$

may be included, together with an objective function such as

maximize ∑t<sub>i</sub>

Since the feasible region if it exists had been unbounded, this objective function will locate the optimum on the new constraint, always giving 1 as the value of the objective function.

The objective function is, however, not without meaning. For a point in the first set, its t is xp-d, while for a point in the second set, its t is d-xp, according to  $X_2p \leq d \leq X_1p$ . This says that t is the perpendicular distance of the point from the plane. Thus the stated objective function is the sum of the perpendicular distance of the n points from the plane. The points in one set being on one side of the plane; and the points in the second set being on the other side. Thus the objective function seeks to maximize, in this sense, the distance of the sets from the plane.

If the linear programming problem does not have a solution, then there is no plane that separates the two sets.

If the linear programming problem does have a solution t, then

$$q = VQ^+U^Tt$$

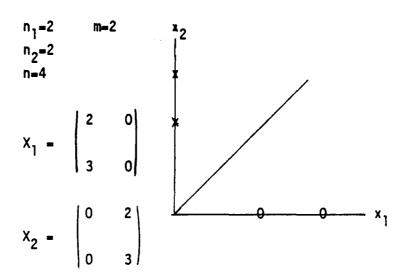
The first m components of q constitute the vector p, and the last component, the (m+1) st is the distance d.

This p and d satisfy

$$x_1p \stackrel{\Delta}{=} d$$
,  $x_2p \stackrel{d}{=} d$ 

so that the plane xp = d discriminates between the two sets.

Example 1: Discriminating planes exist



The points in  $X_1$  are denoted by O, and those in  $X_2$  by X.

To apply the first method, set up the LP problem: find  $y \ge 0$  such that

$$\begin{vmatrix}
2 & 3 & 0 & 0 \\
0 & 0 & -2 & -3 \\
1 & 1 & 0 & 0 \\
0 & 0 & 1 & 1
\end{vmatrix}$$

$$y = \begin{cases}
0 \\
0 \\
1 \\
1
\end{cases}$$

There is a unique solution to the equality for y

which, however, violates the requirement y = 0. Thus the LP problem is non feasible and according to the first method the points can be linearly discriminated. Note how easy the first method is, but how minimal is the information it supplies.

The second method requires finding p and d so that

$$\begin{pmatrix}
2 & 0 & -1 \\
3 & 0 & -1 \\
0 & -2 & 1 \\
0 & -3 & 1
\end{pmatrix}
\qquad
\begin{pmatrix}
p_1 \\
p_2 \\
d
\end{pmatrix}
\Rightarrow
0$$

Some obvious solutions are

$$p = \begin{bmatrix} 1 \\ -1 \end{bmatrix} \qquad -\sqrt{2} \leq d \leq \sqrt{2}$$

Solutions can be produced systematically as follows. The singular value decomposition of the above matrix is

$$\begin{pmatrix} 2 & 0 & -1 \\ 3 & 0 & -1 \\ 0 & -2 & 1 \\ 0 & -3 & 1 \end{pmatrix} = UQV^{T}$$

where

as computed by the IMSL subroutine LSVDF. The solution is

$$\begin{pmatrix} p \\ d \end{pmatrix} = VQ^+U^Tt$$

where t solves

$$I_1 U^T t = 0$$
  $t \stackrel{\wedge}{=} 0$ 

Thus t solves

$$(-.58834842 + .39223228 - .58834839 + .39223226)$$
  $\begin{pmatrix} t_1 \\ t_2 \\ t_3 \\ t_4 \end{pmatrix} = 0$ 

which allows arbitrary choice for  $t_1$ ,  $t_2$ ,  $t_3$  whereupon  $t_4$  is determined by

$$t_4 = (3/2) t_1 - t_2 + (3/2) t_3$$

However, the condition that  $t \stackrel{\triangle}{=} 0$  requires that

$$(3/2)$$
  $(t_1 + t_3) \stackrel{\triangle}{=} t_2 \stackrel{\triangle}{=} 0$ 

To get 
$$|p| = VQ^+U^Tt$$
, the equation for  $Q^+$  is  $Q^+ = \begin{pmatrix} .2433852 & 0 & 0 & 0 \\ 0 & .2773501 & 0 & 0 \\ 0 & 0 & 2.9052994 & 0 \end{pmatrix}$ 

so that

The more exact answer is

$$VQ^+U^T = 1/26$$

$$\begin{pmatrix}
-11 & 16 & 15 & -10 \\
-15 & 10 & 11 & -16 \\
-39 & 26 & 39 & -26
\end{pmatrix}$$

so that

$$= t_1 \begin{pmatrix} 1 \\ 1.5 \\ 3 \end{pmatrix} + t_2 \begin{pmatrix} 1 \\ 1 \\ 2 \end{pmatrix} + t_3 \begin{pmatrix} 1 \\ -0.5 \\ 0 \end{pmatrix}$$

As a check, compute

The components are all obviously non-negative except for the last which is

$$3/2 (t_1+t_3) - t_2$$

and non-negative by choice of  $t_2$  in the range

$$3/2 (t_1 + t_3) \ge t_2 \ge 0$$

While the singular value decomposition is the more useful general approach to computing generalized inverses, the generalized inverse can sometimes be computed more simply and exactly as

$$z^{+}=(z^{+}z)^{-1}z^{T}$$

Thus in example 1

$$Z^{+} = \begin{pmatrix} 13 & 0 & -5 \\ 0 & 13 & -5 \\ -5 & -5 & 4 \end{pmatrix} \quad \begin{array}{c} -1 \\ z^{T} \\ \end{array}$$

Hence the equation for t is

$$0 = (ZZ^+-I) t$$

$$\begin{bmatrix} 1/26 & | 17 & 6 & -9 & 6 \\ 6 & 22 & 6 & -4 \\ -9 & 6 & 17 & 6 \\ 6 & -4 & 6 & 22 \end{bmatrix}$$
 t

which reduces to the single equation

$$0 = -(3/2)t_1+t_2-(3/2)t_3+t_4$$

or

$$t_4 = -(3/2)t_1-t_2+(3/2)t_3$$

The condition that  $t \stackrel{\Delta}{=} 0$  is fulfilled if  $t_1$  and  $t_2$  are arbitrarily chosen as non-negative,  $t_2$  satisfies

$$(3/2)(t_1 + t_3) \stackrel{\triangle}{=} t_2 \stackrel{\triangle}{=} 0$$

and

$$t_4 = (3/2)(t_1 + t_3) - t_2$$

From this, the equation for p and d is

Example 2: Discriminating planes exist

$$n_1=2$$
  $m=2$ 
 $n_2=2$ 
 $n=4$ 
 $X_1 = \begin{bmatrix} 0 & 2 \\ 3 & 0 \end{bmatrix}$ 
 $X_2 = \begin{bmatrix} 2 & 0 \\ 0 & 3 \end{bmatrix}$ 
 $X_3 = \begin{bmatrix} 2 & 0 \\ 0 & 3 \end{bmatrix}$ 

To apply the first method, set up the LP problem: find  $y \ge 0$  such that

$$\begin{pmatrix}
0 & 3 & -2 & 0 \\
2 & 0 & 0 & -3 \\
1 & 1 & 0 & 0 \\
0 & 0 & 1 & 1
\end{pmatrix} \quad y = \begin{pmatrix} 0 \\ 0 \\ 1 \\ 1 \end{pmatrix}$$

There is a unique solution to the equality for y

$$y = (1/5) \begin{pmatrix} 3 \\ 2 \\ 3 \\ 2 \end{pmatrix}$$

which satisfies the requirement  $y \ge 0$ . Thus the LP problem is feasible and according to the first method the points cannot be linearly discriminated. Nonetheless, the second method will be attempted to show the manner in which it will fail.

The second method requires finding p and d so that

$$\begin{vmatrix}
0 & 2 & -1 \\
3 & 0 & -1 \\
-2 & 0 & 1 \\
0 & -3 & 1
\end{vmatrix}$$

$$\begin{vmatrix}
p_1 \\
p_2 \\
d
\end{vmatrix} \stackrel{>}{\Rightarrow} 0$$

No non-trivial solution is possible since the inequalities are

$$3p_1 \stackrel{\checkmark}{=} d \stackrel{\checkmark}{=} 2p_1$$
$$2p_2 \stackrel{\checkmark}{=} d \stackrel{\checkmark}{=} 3p_2$$

The first requires that  $p_1 \stackrel{>}{=} 0$  and  $d \stackrel{>}{=} 0$  while the second requires that  $p_2 \stackrel{>}{=} 0$  and  $d \stackrel{>}{=} 0$ . Thus  $p_1 = p_2 = d = 0$ .

The singular value decomposition of the above matrix is given as

$$\begin{vmatrix}
-2 & 3 & 0 & 0 \\
0 & 0 & 2 & -3 \\
0 & 1 & 1 & 0 \\
1 & 0 & 0 & 1
\end{vmatrix} = UQV^{T}$$

where

as computed by the IMSL subroutine LSVDF. The solution is

$$\begin{pmatrix} p \\ d \end{pmatrix} = VQ^{\dagger}U^{\mathsf{T}}t$$

where t solves

Thus t solves

Thus  $t_1$ ,  $t_2$ ,  $t_3$  can be chosen arbitrarily, but

$$t_4 = 3/2 t_1 - t_2 - 3/2 t_3$$

To satisfy the requirement that  $t \ge 0$ , it is however necessary that

$$t_2 \leq -3/2 (t_1 + t_3)$$

This can be satisfied only if t=0. Thus a discriminating plane cannot be found. Nevertheless for comparison purposes, the process will be pursued further.

To get 
$$\begin{pmatrix} p \\ d \end{pmatrix}$$
 =  $VQ^+U^Tt$ , the equation for  $Q^+$  is

$$Q^{+} = \begin{bmatrix} .243384 & 0 & 0 & 0 \\ 0 & .2773501 & 0 & 0 \\ 0 & 0 & 2.9053003 & 0 \end{bmatrix}$$

so that

$$VQ^+U^T = .4230773$$
 .6153842 -.5769234 -.384615  
.5769309 .384615 -.4230773 -.6153842

or more exactly

$$VQ^+U^T = 1/26$$
 | 11 | 16 | -15 | -10 | 15 | 10 | -11 | -16 | 39 | 26 | -39 | -26 |

so that

$$\begin{vmatrix} p_1 \\ p_2 \\ d \end{vmatrix} = VQ^+U^T$$

$$\begin{vmatrix} t_1 \\ t_2 \\ t_3 \\ t_4 \end{vmatrix}$$

$$= t_1 \begin{pmatrix} 1 \\ 1.5 \\ 0 \end{pmatrix} + t_2 \begin{pmatrix} 1 \\ 1 \\ 2 \end{pmatrix} + t_3 \begin{pmatrix} 0 \\ -0.5 \\ 0 \end{pmatrix}$$

which is zero since as noted earlier, t = 0.

## Reducing Computational Size of Discriminating Plane Method

Typically n is much bigger than m. For example there might be n = 1000 points in an m = 10 dimensional space.

Accordingly U may be very large:  $n \times n$  and V very small:  $m \times m$ . The matrix Q is  $n \times m$  with no more than m non-zero diagonal entries. Hence  $I_1$  is  $n \times n$  with at least n-m non-zero diagonal entries and  $I_2$  is  $n \times n$  with at most m non-zero diagonal entries.

By suppressing zero rows or columns, the problem  $I_1U^Tt=0$ ,  $t\ge 0$  involves an  $(n-m)\times n$  matrix, having 90,000 entries, which is very large. But the problem  $UI_2c\ge 0$  involves an nxm matrix, of 100 entries which is much smaller.

Thus the latter problem is much more tractable with respect to size. However, it entails two difficulties, first it is a non-standard linear programming problem and second, getting to it requires - it would seem - computation of the very large n x n matrix U.

It turns out that both difficulties can be overcome. First U need not be computed explicitly. The singular decomposition representation of Z as UQV where  $UU^T = I$  and  $VV^T = I$  implies that

$$z^{T}z = v^{T}0^{T}0v$$

Thus the singular decomposition calculation applied to the small mxm matrix  $Z^TZ$  can supply V and  $Q^TQ$ . Since the entries in Q can be assumed to be non negative, this also supplies Q. But then

$$ZVQ^+ = UD$$

which is  ${\rm UI}_2$ . Thus the matrix UD which is no bigger than the n x m matrix Z can be gotten without computing the very large n x n matrix U. The non standard linear programming problem

$$UI_2c \ge 0$$

$$1^{\mathsf{T}}\mathsf{UI}_2\mathsf{c}=1$$

is solved next using an approach based on the usual simplex algorithm.

Note that once c is gotten, it can be transformed to q by

$$q = VQ^+U^Tt = VQ^+U^TUI_2c$$

$$= VQ^+I_2c$$

$$= VQ^+c$$

which, again, does not require explicit calculation of U.

## 1.2.5 The Relaxed Discriminant Method

The method described above for construction of a discriminating plane will now be improved upon. When a discriminating plane exists, so that there is a gap between the two sets, the new method produces a pair of parallel planes as far apart as possible, for which the entire gap between them separates the sets. When a discriminating plane does not exist, since the sets overlap, the new method again seeks a pair of parallel planes which are as close to one another as possible, and for which one set is on one side of one plane and the other set is on the other side of the other plane.

The new method, called the Relaxed Discriminant Method is advantageous since it is always able, in theory, to solve any problem and provides additional information where the prior, parent method for discrimination also applies.

Suppose that sets  $X_1$  and  $X_2$  interpenetrate in the sense that there is no plane that lies between the two sets. Consider then the easier task of finding a plane having set  $X_1$ , on one side, and a parallel plane having set  $X_2$  on the other side

$$\begin{array}{c} x_1 p \stackrel{\triangle}{=} d_1 \\ x_2 p \stackrel{\triangle}{=} d_2 \end{array}$$

where  $d_2 \stackrel{\Delta}{=} d_1$ . Thus there can be points, say x, which satisfy both inequalities

$$d_2 \stackrel{\triangle}{=} xp \stackrel{\triangle}{=} d_1$$
.

By making  $d_2$  and  $d_1$  as close together as possible, a band is determined which discriminates between the two sets in the sense that all points on one side of the band belong to  $X_1$ , and all points on the other side belong to  $X_2$ .

Thus the band satisfies a relaxed discriminant problem. But it serves other important purposes. First it identifies the troublesome points, being the points within the band. These may be found to be suspect for some reason. Or the points may be found to have sufficient observational error that the band can be collapsed to a plane. If the validity of the points is, upon examination, not impugned, then three approaches are available. One approach is to say that within the band, the sets cannot be discriminated — which may be acceptable if the band is narrow. A second approach is to introduce probabilities so that all sets are assumed to interpenetrate and all that can be said is the probability that a point belongs to any particular set. The third approach is to use a nonlinear discriminant surface, which would fit within the band separating the members of the sets within the band. It would seem that constructing such a surface would be helped by knowledge of the band and the difficult points within the band.

Note that the case  $d_1 \stackrel{\rightharpoonup}{=} d_2$  is also of considerable interest since a band is thereby defined which contains points of neither set. The plane bisecting the band discriminates the two sets, and would not have any marginal points which are on the border line between the two sets. The band, however, also indicates a region in which there is no data, and might with more data be found to be assignable to the two sets in some manner.

The problem to be solved is therefore to find p,  $d_1$  and  $d_2$  such that

$$X_{1} p \stackrel{\triangle}{=} d_{1}$$

$$X_{2} p \stackrel{\triangle}{=} d_{2}$$

$$d_{2} - d_{1} \stackrel{\triangle}{=} 0$$

For the case of interpenetrating sets  $d_2 - d_1$  cannot be less than some positive quantity; it is desirable to minimize  $d_2 - d_1$ .

The above problem for interpenetrating sets can be written in matrix form as maximizing  $d_1$  -  $d_2$  subject to

or

$$Zq \stackrel{>}{=} 0$$

The solution is given by  $q = Z^{+}t$  provided that

and

$$(ZZ^{+} - I) t = 0$$

The latter equation reduces as before to

$$I_1 U^T t = 0$$

where U is part of the singular value decomposition of Z, that is Z =  $UQV^T$  and  $I_1$  is a diagonal matrix whose ii entry is 0 if  $q_{ij} \neq 0$  and +1 if  $q_{ij} = 0$ .

If there are n rows in  $X_1$  and  $X_2$  combined, and they have m columns each, then U is an  $(n + 1) \times (n + 1)$  matrix and Q is  $(n + 1) \times (m + 2)$ .

If r is the rank of Q then  $I_1$  has only n+1-r non zero rows. Thus  $I_1$   $U^T$  can be written as an (n+1-r) x (n+1) matrix.

The problem is now in standard linear programming form: find t such that

$$t \rightarrow 0$$

$$I_1 U^T t = 0$$

 $maximize -t_{n+1}$ 

If the constraints however are satisfied by a vector  $\hat{\tau}$ , then they are also satisfied by any positive multiple of  $\hat{\tau}$ . The objective function would drive that multiple to 0.

This unsatisfactory situation also can be seen in the problem as originally stated, by letting p=0,  $d_1=0$ ,  $d_2=0$ . Clearly it arises because no constraint was imposed on the length of p, such as the classical constraint that  $\|p\|=1$ . Such a constraint would introduce a nonlinear aspect and so is to be avoided. Instead the linear constraint

will be used. The objective function should drive any solution to the  $\sum t_i = 1$  plane, since if t is a solution, not on the planes then k  $\hat{t}$ ,  $k = 1/\sum \hat{t}_i$  is also a solution has smaller  $t_{n+1}$  and is on the plane.

The new constraint specifies that the distances of each point from its bounding plane add to at least one; the distances being defined so as to be always positive.

Consider now the problem when the sets are separated, and as wide a band as possible is sought between them. In algebraic terms the problem is to find p,  $d_1$ ,  $d_2$  so that

$$\begin{vmatrix} x_1 & -1 & 0 & p \\ -x_2 & 0 & +1 & d_1 \\ 0 & 1 & -1 & d_2 \end{vmatrix} = \begin{vmatrix} t_1 \\ t_2 \\ \vdots \\ t_{n+1} \end{vmatrix} \ge 0$$

and  $t_5 = d_1 - d_2$  is maximized.

Converted to standard linear programming form, the problem is to find t such that

$$I_1 U^T t = 0$$

Maximize t<sub>n+1</sub>

Here again, if the constraints are satisfied by  $\hat{\tau}$ , they are also satisfied by any positive multiple of  $\hat{\tau}$ , and the objective function drives that multiple to infinity. The reason is that the problem has not been normalized. To do so here the additional constraint

$$\sum_{i=1}^{n} t_{i} \leq 1$$

1=1

is imposed.

The intersection and the separation problems can now be combined as:

Find p,  $d_1$   $d_2$  such that

$$\begin{pmatrix} x_1 & -1 & 0 \\ -x_2 & 0 & +1 \\ 0 & +1 & \pm 1 \end{pmatrix} \quad \begin{pmatrix} p \\ d_1 \\ d_2 \end{pmatrix} = \quad \begin{pmatrix} t_1 \\ t_2 \\ \vdots \\ t_{n+1} \end{pmatrix} \stackrel{}{=} \quad 0$$

$$\pm \sum_{i} f^{i} = \pi_{i}$$

maximize  $= t_{n+1}$ 

or, in standard form: Find t such that

$$I_1 U^T t = 0$$

$$\pm \sum_{i} t_{i} \geq \pm 1$$

 $Maximize \mp t_{n+1}$ 

where the upper signs are for the intersection problem and the lower for the separation problem. Here  $\mathsf{UQV}^\mathsf{T}$  is the singular value decomposition of

and  $I_{\mbox{\scriptsize 1}}$  is a square diagonal matrix whose ii entry is 0 if  $q_{\mbox{\scriptsize 1}\mbox{\scriptsize 1}}\neq 0$  and is +1 if  $q_{\mbox{\scriptsize 1}\mbox{\scriptsize 1}}=0.$ 

Since the labeling of sets is arbitrary, it is of interest to determine what happens if the labels on sets 1 and 2 were interchanged.

The matrix equation in geometric variables is

$$\begin{pmatrix} x_2 & -1 & 0 \\ -x_1 & 0 & +0 \\ 0 & \mp 1 & \pm 1 \end{pmatrix} \qquad \begin{pmatrix} p \\ d_1 \\ d_2 \end{pmatrix} \qquad = \qquad \begin{pmatrix} t_1 \\ \vdots \\ t_{n+1} \end{pmatrix} \qquad \stackrel{\triangle}{=} \qquad 0$$

This can be rewritten successively as

$$\begin{pmatrix} -X_{2} & -1 & 0 \\ X_{1} & 0 & +0 \\ 0 & \mp 1 & \pm 1 \end{pmatrix} \qquad \begin{pmatrix} -p \\ d_{1} \\ d_{2} \end{pmatrix} \qquad = \qquad \begin{pmatrix} t_{1} \\ t_{n+1} \end{pmatrix} \qquad \triangleq \qquad 0$$

$$\begin{pmatrix} x_1 & & +1 & 0 \\ -x_2 & & -1 & +1 \\ 0 & & \pm 1 & \pm 1 \end{pmatrix} \qquad \begin{pmatrix} -p \\ d_2 \\ d_1 \end{pmatrix} \qquad = \qquad \begin{pmatrix} t_{n1+1} \\ \vdots \\ t_{n1+n2} \\ \vdots \\ \vdots \\ t_{n1} \\ t_{n+1} \end{pmatrix}$$

$$\begin{pmatrix} x_1 & & +1 & 0 \\ -x_2 & & -1 & +1 \\ 0 & & \pm 1 & \pm 1 \end{pmatrix} \qquad \begin{pmatrix} -p \\ -d_2 \\ -d_1 \end{pmatrix} \qquad = \qquad \begin{pmatrix} t_{n1+1} \\ \vdots \\ \vdots \\ t_{n1+n2} \\ \vdots \\ \vdots \\ t_{n1+n2} \\ t_1 \\ \vdots \end{pmatrix} \Rightarrow 0$$

The normalizing constraint

$$\pm \sum_{t_1} \pm +1$$

is unchanged as is the objective function.

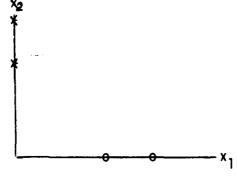
Thus, the solution of the problem for sets  $X_2$ ,  $X_1$  is the negative of the solution for sets  $X_1$ ,  $X_2$ . Thus, the same discriminating planes result no matter which labeling is used.

Example 1: The two sets are separated

$$n_1=2$$
,  $n_2=2$ ,  $n=4$ ,  $m=2$ 

$$X_1 = \begin{bmatrix} 2 & 0 \\ 3 & 0 \end{bmatrix}$$
 marked with o

$$X_2 = \begin{bmatrix} 0 & 2 \\ 0 & 3 \end{bmatrix}$$
 marked with x



It is required to solve

$$\begin{pmatrix} 2 & 0 & -1 & 0 \\ 3 & 0 & -1 & 0 \\ 2 & 0 & 1 & 1 \\ 0 & -3 & 0 & 1 \\ 0 & 0 & 1 & -1 \end{pmatrix} \begin{pmatrix} p_1 \\ p_2 \\ d_1 \\ d_2 \end{pmatrix} = \begin{pmatrix} t_1 \\ t_2 \\ t_3 \\ t_4 \\ t_5 \end{pmatrix} \implies 0$$

Solving the first four equations gives

$$\begin{pmatrix} p_1 \\ p_2 \\ d_1 \\ d_2 \end{pmatrix} = \begin{pmatrix} -1 & 1 & & \\ & & 1 - 1 \\ -3 & 2 & & \\ & & 3 - 2 \end{pmatrix} \begin{pmatrix} t_1 \\ t_2 \\ t_3 \\ t_4 \end{pmatrix}$$

so that

$$t_5 = d_1 - d_2 = -3(t_1 + t_3) + 2(t_2 + t_4)$$

The constraint

$$1=t_1+t_2+t_3+t_4$$

implies that

$$-(t_1+t_3)=(t_2+t_4)-1$$

so that

$$t_5=3[-1+(t_2+t_4)]+2(t_2+t_4)]$$
  
=5(t2t4)-3

and  $t_5 \ge 0$  requires that  $t_2 + t_4 \ge 3/5$ 

Since  $d_1-d_2$ , which is  $t_5$ , is to be maximized, it follows that  $t_2+t_4$  is to be maximized. Since the t's are non-negative, the optimum choice is

$$t_1 = t_3 = 0$$
  $t_2 + t_4 = 1$ 

This gives

$$p_1 = t_2$$

$$p_2 = -t_4 = t_2 - 1$$

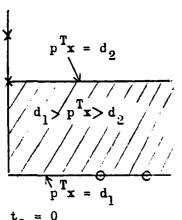
$$d_1 = 2t_2$$

$$d_2 = -2t_4 = 2t_2 - 2$$

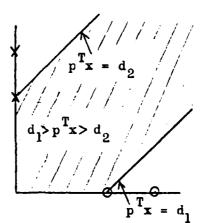
and

$$d_1 - d_2 = 2$$

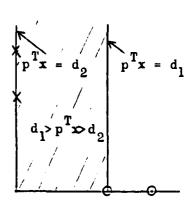
with  $t_2$  undetermined in the range of  $0 \le t_2 \le 1$ . The following shows the situation for  $t_2$ =0, 1/2, 1.



$$t_2 = 0$$
 $p = \begin{pmatrix} 0 \\ -1 \end{pmatrix}, d_1 = 0, d_2 = -2$ 
 $d_1 - d_2 = 2$ 



$$t_2 = 1/2$$
 $p = {1/2 \choose -1/2}, d_1 = 1, d_2 = -1$ 
 $d_1 - d_2 = 2$ 



$$t_2 = 1$$
 $p = {1 \choose 0}$ ,  $d_1 = 2$ ,  $d_2 = 0$ 
 $d_1 - d_2 = 2$ 

Here the shaded region is prohibited for either set of points. Now consider the inequality constraint

$$1 \stackrel{\triangle}{=} t_1 + t_2 + t_3 + t_4$$

which says that

$$(t_1 + t_3) \leq -(t_2 + t_4) + 1$$

The constraint  $t_5 \ge 0$  implies that

$$(t_1+t_3) \leq (2/3)(t_2+t_4)$$

Choosing  $t_1+t_3=0$  does not constrain the choice of  $t_2+t_4$  and benefits the objective. The constraint then on  $t_2+t_4$  is simply

$$0 \le t_2 + t_4 \le 1$$

Choosing  $t_2^{-1}t_4^{-1}$  benefits the objective most.

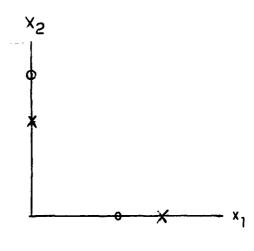
Thus, the inequality constraint  $1 extstyle t_1 + t_2 + t_3 + t_4$  leads to the same result as the equality constraint  $1 = t_1 + t_2 + t_3 + t_4$ .

Example 2: The two sets are separated

$$n_1=2$$
,  $n_2=2$ ,  $n+4$ ,  $m=2$ 

$$X_1 = \begin{bmatrix} 0 & 2 \\ 3 & 0 \end{bmatrix}$$
 marked with o

$$X_2 = \begin{pmatrix} 2 & 0 \\ 0 & 3 \end{pmatrix}$$
 marked with x



It is required to solve

$$\begin{vmatrix} 0 & 2 & -1 & 0 \\ 3 & 0 & -1 & 0 \\ -2 & 0 & 0 & 1 \\ 0 & -3 & 0 & 1 \\ 0 & 0 & -1 & 1 \end{vmatrix} \begin{vmatrix} p_1 \\ p_2 \\ d_1 \\ d_2 \end{vmatrix} = \begin{vmatrix} t_1 \\ t_2 \\ t_3 \\ t_4 \\ t_5 \end{vmatrix} \qquad \stackrel{\triangle}{=} \qquad 0$$

Solving the first four equations gives

$$\begin{vmatrix} p_1 \\ p_2 \\ d_1 \\ d_2 \end{vmatrix} = 1/5 \begin{vmatrix} -3 & 3 & 2 & -2 \\ -2 & 2 & 3 & -3 \\ -9 & 4 & 6 & -6 \\ -6 & 6 & 9 & -4 \end{vmatrix} \begin{vmatrix} t_1 \\ t_2 \\ t_3 \\ t_4 \end{vmatrix}$$

so that

$$t_5 = -d_1 + d_2 = (3/5)(t_1 + t_3) + (2/5)(t_2 + t_4)$$

The constraint  $t_5$ = 0 is implied by the constraints  $t_i \ge 0$ , i=1,...4.

The constraint

implies that

$$t_5 = (3/5)[1 - (t_2 + t_4)] + (2/5)(t_2 + t_4)$$

$$=3/5-(1/5)(t_2t_4)$$

Since  $d_1-d_2$ , which is  $-t_5$ , is to be maximized,  $t_2+t_4$  is to be maximized. Since the t's are non-negative, the optimum choice is

$$t_1 = t_3 = 0,$$
  $t_2 + t_4 = 1$ 

This gives

$$p_1 = (3/5)t_2 - (2/5)t_4 = t_2 - 2/5$$
  
 $p_2 = (2/5)t_2 - (3/5)t_4 = t_2 - 3/5$   
 $d_1 = (4/5)t_2 - (6/5)t_4 = 2t_2 - 6/5$ 

$$d_1 = (4/5)t_2 - (6/5)t_4 = 2t_2 - 6/5$$

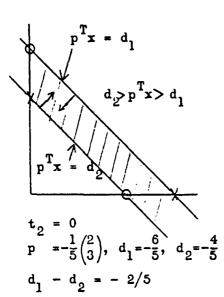
$$d_2 = (6/5)t_1 - (4/5)t_2 - t_3 - 4/5$$

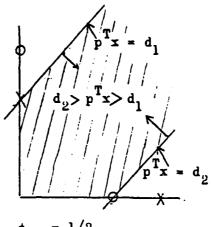
$$d_1 = (6/5)t_2 - (4/5)t_4 = t_2 - 4/5$$

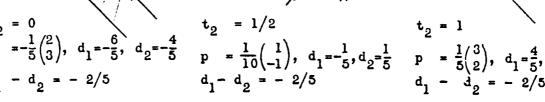
and

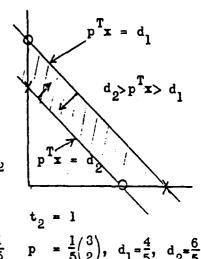
$$d_1 - d_2 = -2/5$$

with  $t_2$  undetermined in the range of  $0 \le t_2 \le 1$ . The following shows the situation for  $t_2=0$ , 1/2, 1.









The shaded region is the overlap region available to both sets.

Consider now the inequality constraint

$$1 \leq t_1 + t_2 + t_3 + t_4$$

The objective

$$-t_5 = -(1/5)(t_1+t_3)-(2/5)(t_1+t_2+t_3+t_4)$$

is maximized by choosing  $t_1+t_3$  small, as well as  $t_1+t_2+t_3+t_4$  small; these are not in conflict. Thus  $t_1=t_3=0$  and  $t_2+t_4=1$  as was found before.

## 1.2.6 Cluster Analysis

A cluster might be defined as a set of points such that between any two points  $x^A$ ,  $x^B$  in the cluster there is a sequence of points in the cluster:  $x^A$ ,  $x^1$ ,  $x^2$ .... $x^B$  which are close to one another in the sense

$$\|x^{A}-x^{1}\| \leq d$$
  
 $\|x^{i}-x^{i+1}\| \leq d$ ,  $1 \leq i \leq i-1$   
 $\|x^{I}-x^{B}\| \leq d$ 

for some distance d. Here  $\|x\|$  means Euclidean length that is  $\|x\| = \left[\sum x_i^2\right]^{1/2}$  where the  $x_i$  are the components of x.

Which points would be included in the cluster would clearly be dependent on the value of d. For some situations, in which a reasonable value of d may not be clear, it is therefore desirable to define a cluster differently in a more intrinsic, topological manner, independent of the choice of d. Such a definition has a special significance even when suitable d values may be estimated, since the clusters thus defined have an absolute, intrinsic m

The new definition will involve use of two metrics, the familiar Euclidean metric

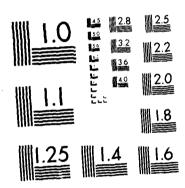
$$\|x^{A} - x\| = \left[\sum_{k=1}^{n} (x^{A} - x^{B})^{2}\right]^{1/2}$$

and a new metric which will be called a Stepping Stone metric.

Between points  $x^A$  and  $x^B$ , there are many sequences

$$s = [x^A = x^0, x^1, x^2, \dots x^I, x^{I+1} = x^B]$$

EMPIRICAL FLUTTER PREDICTION METHOD(U) GE ATRCRMFT ENGINES CINCINNATI OH ADVANCED TECHNOLOGY OPERATION J K CASEY 05 MAR 88 R87AEG AFMAL-TR-87-2087 F33615-84-C-2457 F/G 20/4 ND-N193 699 UNCLASSIFIED F/G 28/4 NL



of points. For each sequence, the maximum distance between successive points is

$$d_s = \max_{0 \le j \le I} ||x^j - x^{j+1}||$$

where I depends on the sequence s. The quantity  $d_s$  will be called the Stepping Stone distance along the sequence s from  $x^A$  to  $x^B$ . For the set S of all such sequences, choose the least of the  $d_s$  values

Thus, d is the largest step that one is <u>obligated</u> to take in going from  $x^A$  to  $x^B$ . The quantity d will be called simply the Stepping Stone distance between points  $x^A$  and  $x^B$ .

This distance satisfies the three properties of a metric since the Stepping Stone distance is always non-negative, is 0 if  $x^B = x^A$ , is the same from  $x^A$  to  $x^B$  as from  $x^B$  to  $x^A$ , and it satisfies the triangle inequality:

$$d(x^A, x^C) \leq d(x^A, x^B) + d(x^B, x^C)$$

since the path from  $x^A$  to  $x^B$  to  $x^C$  having Stepping Stone distances  $d(x^A, x^B)$  and  $d(x^A, x^C)$ , respectively, is one of the paths considered for  $d(x^A, x^C)$  and for this particular path the Stepping Stone distance is

min 
$$(d(x^A, x^B), d(x^B, x^C))$$

which is less than or equal to the sum.

The Stepping Stone distance between  $x^A$  and  $x^B$  is thus the Euclidean distance between two points, say  $x^I$ ,  $x^{I+1}$  in a certain sequence

$$x^A$$
, ...,  $x^I$ ,  $x^{I+1}$ , ...,  $x^B$ 

which goes from  $x^A$  to  $x^B$ . The point  $x^I$  is defined as the frontier point for going from  $x^A$  to  $x^B$  and  $x^{I+1}$  is defined as the frontier point for going from  $x^B$ .

A cluster is defined as a set of points which includes all their frontier points and cannot be decomposed into smaller clusters. A point which is not a frontier point in going from one cluster to another is called an interior point.

The computation of clusters according to these concepts can best be carried out in terms of two m \* m matrices where m is the number of data points. The i,j entry for one matrix is the Stepping Stone distance from point i to point j. In another matrix, the i,j entry is the frontier point number for going from point i to point j.

The matrix of Stepping Stone distances is initialized to the Euclidean distance between points. The matrix is continually swept, replacing at each step the ij entry by the maximum of the i, k and k,j entries if this produces a smaller i,j entry. Thus, if (the biggest step required in going from point i to point k) and (the biggest step required in going from point k to point j) are less than (the biggest step found thus far to be required in going from i to j), then the maximum of the former replaces the latter. The sweeping continues until no more change occurs.

The matrix of frontier points is initialized so that the i,j entry is i if below the diagonal and is j if above the diagonal, the diagonal entries being set to 0 and subsequently ignored. If the ik Stepping Stone distance replaces the ij Stepping Stone distance, then the ik frontier entry replaces the ij entry and the ki entry replaces the ji entry. Conversely, if the kj Stepping Stone entry replaces the ij entry, then the kj frontier entry replaces the ij entry and the jk entry replaces the ji entry.

Membership in the first cluster is determined by picking a point arbitrarily, then including it and all its frontier points in the

cluster, then all their frontier points, etc., and finally all interior points which have frontier points in the cluster. Membership in the next cluster is determined in the same way beginning with any point not already assigned to a cluster.

Certain refinements may be mentioned but will not be discussed in detail. These include: the case in which the ik Stepping Stone distance equals the kj, and is less than the ij Stepping Stone distance, or the case in which both equal the ij Stepping Stone distance; the case in which subclusters exist; the case in which bonds are defined to force two points and their clusters to be combined into the same cluster.

A special point of interest is that this approach to clusters does not require a prior definition of smallness by the user, which can often be a difficult requirement. Instead, the definition of cluster here is more intrinsic.

Another interesting feature of this approach is that two metrics are being simultaneously employed. And the pivotally important frontier points have the property that the two metrics coincide on pairs of frontier points, which are thus intrinsically distinguished points.

In establishing certain properties of clusters generated in this way, some notation will be useful. Let  $a_1, a_2, \ldots$  be interior points and  $\alpha_1, \alpha_2, \ldots$  frontier points of a cluster A; and  $b_1, b_2, \ldots$  and  $\beta_1, \beta_2, \ldots$  the interior and frontier points of a different cluster B; etc. The Stepping Stone metric will be assumed in speaking of the distance between points, or the closeness of points.

Frontier points are defined in pairs; one frontier point is said to be the pair of the other. The points of a cluster for which a point  $\alpha$  is a frontier point are said to belong to  $\alpha$ . Also, the set of points which are frontier points for an interior point a, are said to belong to a. The operator T applied to a set of points produces all the points which are frontier points for at least one of the interior points.

$$T(a) = [\alpha_1, \alpha_2, \dots]$$

The inverse operator  $T^{-1}$  applies to frontier points  $\alpha_1, \alpha_2, \ldots$  and produces all points for which these are frontier points.

$$T^{-1}(0) = [a_1, a_2, \dots]$$

Note that a frontier point is a frontier point for itself. Also, a frontier point  $\alpha_1$  in going from cluster A to cluster B may use  $\alpha_2$  as its frontier in going from cluster A to cluster C.

Points belonging to a frontier point  $\alpha$  are no further from one another than  $\alpha$  is from its pair. This follows since otherwise one such point would be further from  $\alpha$ , and from its pair than is  $\alpha$ .

We can show that the frontier point for a cluster which is most distant from its pair is a frontier point for all points in its cluster. Thus, the points of a cluster are no further from one another than this frontier point is from its pair. Hence, there is at least one frontier point which can serve the entire cluster. Such a frontier point will be called a capital frontier point.

To prove this result, suppose the contrary, that  $\alpha_1$  cannot serve the entire cluster. Suppose that the frontier point in question,  $\operatorname{say}\alpha_1$ , is a distance  $\operatorname{d}_1$  from its  $\operatorname{pair}\beta_1$ , and that the points  $\operatorname{T}^{-1}(\alpha_1)$  which belong to it do not exhaust the cluster but that there is another frontier  $\operatorname{point}\alpha_2$  whose  $\operatorname{pair}\beta_2$  is in the same cluster B as  $\beta$  and that  $\operatorname{T}^{-1}(\alpha_2)$  has no points in common with  $\operatorname{T}^{-1}(\alpha_1)$ . Suppose that the distance from  $\alpha_2$  to  $\beta_2$  is  $\operatorname{d}_2$ , and that d is the least distance between points of  $\operatorname{T}^{-1}(\alpha_1)$  and points of  $\operatorname{T}^{-1}(\alpha_2)$ . By hypothesis  $\operatorname{d}_2 \subseteq \operatorname{d}_1$ .

If  $d = d_1$  and  $d_2 = d_1$ , then there are points of  $T^{-1}(\alpha_1)$  which have a shorter path to B by going through  $\alpha_2$ , which is contrary to assumption. If  $d = d_1$  and  $d_2 = d_1$ , then  $\alpha_1$  can serve as frontier for both  $T^{-1}(\alpha_1)$  and  $T^{-1}(\alpha_2)$  which is also contrary to assumption. Hence, d must exceed  $d_1$ .

But since any frontier point for points of  $T^{-1}(\alpha_1)$  is no more than  $d_1$  from its pair, no points belonging to them are more than  $d_1$  apart and so there can be no point belonging to them which is in  $T^{-1}(\alpha_2)$ . Since the points of a cluster are generated by T or  $T^{-1}$  operations, no such operation on a point generated from a, can ever produce a point of  $T^{-1}(\alpha_2)$ . Thus, the assumption that  $\alpha_1$  and  $\alpha_2$  are in the same cluster is untenable. Thus  $\alpha_1$  can serve the entire cluster; any other frontier point  $\alpha_2$  with its pair in B is thus redundant. The other assertions follow directly.

It follows further that if any point of the cluster is chosen, the operation  $T(\alpha)$  will produce a capital frontier point and so  $T^{-1}T(\alpha)$  will produce the entire cluster. Were this conclusion not established, the questions could be raised whether the membership in a cluster would be independent of which point was selected first as generator, and also whether one sequence of T,  $T^{-1}$  would generate a different cluster than another sequence.

Clusters thus have the intuitive property that the distance within the cluster is less than the distance between clusters, where the latter distance means the distance to the furthest cluster.

Clusters have several different uses in the analysis of large sets of data.

One use is to discover types of points. The points of one type will differ in each variable by a large amount from the points of the other type, the quantity being considerably more than the differences within each type. This usage is sometimes called taxonomic since it discovers natural groupings. It has been used in this way to discover species or subspecies of animals, and to discover different types of voter or comsumer requiring different persuasions. This usage of clusters is the one most often addressed in the literature.

In the above use, clusters would be sought with respect to behavior or performance or response variables. Once this were done, corresponding clusters might be sought among descriptive or predictive or causal variables. The underlying idea would be that the former are effects while the latter are causes. Dichotomous differences in effects suggest dichotomous differences in causes. This is the case if the cause effect relation is continuous. But it need not always be the case since some causal factors can produce a discontinuous effect relative to some threshold value, so that a small change in the causal variable can produce a discontinuous jump in a response.

The first sort of usage does not apply to the flutter prediction problem. Here the types of behavior are the different kinds of stability condition, which are known beforehand for the Annular Cascade Data Base. What is of interest, therefore, are the corresponding clusters in the space of predictive variables. But here it is well known that there are transition regions where a small change in these variables can make a large qualitative change in the stability condition. Furthermore, the subset of the Annular Cascade Data Base which, in the interest of computer economy was used, are principally the points in these transition regions. Thus the points selected form clusters which intentionally contain points of different stability conditions.

It might be mentioned parenthetically that an example in jet engine technology of the fruitful use of these two types of cluster application might arise in analysis of repair/operational problems of jet engines. Do these separate into clusters? into syndromes? If so, these clusters would be the behavioral types. Then we would ask whether there were corresponding clusters in the space of engine history/operation. These would be the causal clusters. This correspondence would suggest that an engine in a certain operational cluster will develop a certain syndrome of performance problems.

The cluster concept also has a third, quite different use, which is the use of greater importance for the empirical flutter prediction problem.

Suppose there is no big separation between the predictive variables that correspond to one type of behavior and the predictive variables that correspond to a different type of behavior. If the predictive variables are sufficient to predict behavior, there must be a surface running through them such that points on one side produce one type of behavior, while points on the other side produce a different type of behavior.

Discovery of such a surface is the task of discriminant analysis, which is easier to the extent that the surface is not tightly crowded by points on each side. If it is crowded, then a nonlinear surface may be needed, and it will be necessary to identify where the surface is tightly crowded, that is, where the surface must thread through a cluster having points of two or more different behavioral types.

Thus, the third use of cluster analysis is to locate clusters in the space of predictive values for points of two or more behavioral types.

The task of proposing a nonlinear surface separating the two behavioral types is thereby simplified since the clusters can initially be viewed as single "points." The nonlinear surface should traverse the "points" of mixed behavioral type and separate those of single behavioral type.

Indeed, clusters of a single behavioral type may very possibly be irrelevant to the problem of finding a discriminating plane, provided there are enough clusters of mixed stability type to define the planes.

There is still a fourth use of clusters. This concerns the geometric shape of the cluster.

Consider the center of gravity of a cluster, that is the point whose coordinates are the average of the corresponding coordinates of the members of the clusters.

If the center of gravity is inside the cluster, this suggests the cluster is convex; if outside the cluster, concavity is indicated.

The same question can, of course, be asked relative to convex hulls of the cluster. And the answers may be different. For example, if the points of the cluster were distributed over a half circle, the answers would be different; while if they were distributed over a circle, the answers would be the same.

#### 2.0 GALACTIC Applied To Annular Cascade Data Base

GALACTIC was applied to 891 test points selected from the much larger Annular Cascade Data Base.

These points were selected because they were in the transition regions between stability regions. This selection served to reduce the total number of points required and so to minimize computer storage and running time. At the same time, this selection excluded most "easy points," making it difficult to find planes that separated any two stability regions since the plane was constrained to lie between points close on either side.

While the Annular Cascade Data Base contains a great deal of information about each test point, production engine test points would have much less information. Accordingly, it would be impractical to use more information from the Annular Cascade Data Base than could be expected from production engine test points. For this reason, GALACTIC used only the following nine items of aeromechanical data for each test point:

<u>Name</u>	<u>Meaning</u>
PIN	Pressure at inlet
TINLET	Temperature at Inlet
SLUTYA	Solidity
REY	Reynold's number
INC	Leading edge angle of incidence
MLE	Mach number at leading edge
VLE875	Velocity at a point on the leading edge
	distant from the blade root by $87.5\%$ of
	the span
REDV1	Reduced velocity - flexure
REDV2	Reduced velocity - torsion

The 891 test points populated 14 stability regions:

Stability	Number	
Code	of Points	Stability Region
00	209	Stall; stable
01	137	Stall; flexural flutter
02	56	Stall; torsional flutter
03	22	Stall; flexural and torsional flutter
04	15	Stall; 2nd flexural flutter
05	2	Stall; 1 flex., 1 tors., 2 flex. flutter
06	1	Stall; 1 flex., 2 flex. flutter
07	31	Stall; separated flow
10	201	Interior, stable
20	73	Choke; stable
21	126	Choke; flexural flutter
22	13	Choke; torsional flutter
23	4	Choke; flex. and torsional flutter
27	_1	Choke; separated flow
	891	

### These may be combined as:

376	Flutter (9 regions)
483	Stable (3 regions)
_32	Separated Flow (2 regions)
891	

or as

473	Stall (8	regions)
217	Choke (5	regions)
201	Interior	(1 region)
891		

The 14 stability regions produce

 $13 + 12 + \dots + 1 = 91$ 

pairs of stability regions and therefore require an equal number of hyperplanes to separate them — or more correctly — pairs of hyperplanes since the Relaxed Discriminant Method is used.

The 91 hyperplanes were produced over a 23-day period and required 31 computer runs and up to 10 hours VAX4 processor time per run.

#### 2.1 <u>Intersecting Pairs of Stability Regions</u>

For 21 of 91 pairs of stability regions, the Discriminant Feasibility Method found that the regions intersect one another (i.e. the convex hulls intersect). The Relaxed Discriminant method proceeds to find pairs of hyperplanes which in all these cases show an overlap, as expected. The overlaps are generally not large; their width may be compared to one another and to unity since all variables had been normalized to have a range of from 0 to 1. The following provides details on these 21 pairs of stability regions: overlap width, the number of points in each pair of stability regions, the percents of these points which are in the overlap region, which are outside the overlap region on the correct or on the incorrect side.

Stall. Stall Pairs (9 out of 28 pairs = 32%)

Stability	Stability	Overlap	7.	7.	7.	Number
Code	Code	Width	<u>Correct</u>	<u>Incorrect</u>	<u> Overlap</u>	of Points
00	01	0.023	40	8	53	346
00	02	0.260	45	0.4	55	265
00	03	0.137	12	0	88	231
CO	04	0.043	78	0.4	21	224
00	07	0.104	45	2	54	240
01	02	0.054	23	0	77	193
01	03	0.0002	83	10	7	159
01	07	0.004	61	15	23	168
02	03	0.002	78	8	14	78
Chol	ke, Choke Pai	<u>rs</u> (2 out	of 10 = 20%	4)		
20	21	0.030	62	5	33	199
21	22	0.002	58	13	29	139
<u>Stal</u>	ll. Choke Pai	<u>rs</u> (1 out	of 40 = 2.5	5%)		
02	22	0.017	48	3	49	69
Inte	erior, Stall	<u>Pairs</u> (6 o	ut of 8 = 7	75%)		
10	00	0.792	0.7	0.2	99	410
10	01	0.032	66	4	30	338
10	02	0.002	93	3	4	257
10	03	0.00005	96	2	2	223
10	04	0.230	50	0.5	50	216
10	07	0.027	84	2	14	232

Interior. Choke Pairs (3 out of 5 = 60%)

Stability <u>Code</u>	StabilityCode	Overlap <u>Width</u>	% Correct	% Incorrect	% Overlap	Number of Points
10	20	0.437	4	0.7	95	274
10	21	0.327	5	0.6	94	327
10	22	0.008	77	3	20	214

Several observations can now be made, based largely on the above details.

- o The interior region showed the most intersections whether with stall or with choke regions.
- o The fewest intersecting pairs occurred between the choke and stall regions.
- o Even for the 21 pairs of intersecting stability regions, there were relatively few test points on the incorrect side of the hyperplanes, and the pairs with the most incorrect points have especially narrow overlap regions. Thus, the incorrect points may have been only slightly in error.
- o Most overlaps have narrow width, suggesting that a slightly nonlinear surface might serve to discriminate between the two stability regions.
- o Substantial numbers of points fall into many of the overlap zones, making the hyperplanes in such cases ambiguous and of little help in discriminating between the stability regions they were to separate.
- o The Discriminant Feasibility Method is virtually foolproof in declaring that two regions intersect since it constructs a common point. The conclusion that two regions are disjoint, that is, that a common point could not be found, is not as foolproof.

o The Relaxed Discriminant Method is seen to work consistently with the Discriminant Feasibility Method in that, in all 21 cases, it produced hyperplanes with overlaps.

#### 2.2 <u>Disjoint Pairs of Stability Regions</u>

For 70 of 91 pairs of stability regions the Discriminant Feasiblity Method found that the regions are disjoint (i.e. the convex hulls do not intersect). This conclusion is not, however, foolproof, since it is based on the negative result that a point common to the two regions could not be found.

However, in all but one case the conclusion was confirmed by the Relaxed Discriminant Method finding discriminating pairs of hyperplanes. Usually, the pairs of planes have a gap, as is expected. But in some cases the iteration counter ran out on the gap case, and the overlap case was tried and resulted in a slight overlap (say less than 0.01), or perhaps a negative overlap. In a few cases, neither the gap nor the overlap case was successfully concluded before the iteration counter was exhausted and the latest hyperplane pair was accepted with, again, no more than a slight overlap.

In three cases there was an important difference between the two methods, namely for regions (00,20), (00,21) and (10,23). Here the Discriminant Feasibility Method declared that the two regions are disjoint, but the Relaxed Discriminant Method was unable to successfully conclude either the gap or overlap case. When the iteration counter ran out, the hyperplane pair had, respectively, an overlap of 1.31 with 22 percent of the points in the wrong region, a gap of 0.002 but 39 percent in the wrong region, and an overlap of 0.281 with 100 percent of the points in the overlap zone.

Two possible explanations are either that the Discriminant Feasibility Method failing to construct a point common to both regions declared

disjointness prematurely, or that the Relaxed Discriminant Method terminated prematurely. Which explanation is correct has not been ascertained.

#### 2.3 Conclusions

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The above discussion accounts for all but a very few scattered instances of points falling into overlap regions and, therefore, not being discriminated by the hyperplane pairs — and these points may have been borderline.

For 23 percent of the pairs of stability regions (21 of 91), the stability regions appear to intersect and to require a nonlinear surface to fully discriminate between the regions.

For 74 percent of the pairs of stability regions, a linear discriminating surface, that is a hyperplane, can discriminate between the two regions.

For three cases, 3 percent, it is not clear to which category they belong.

The voting procedure in EFAGHY can compensate to some extent for ambiguous hyperplane pairs, that is pairs with an appreciable overlap zone, since even though the correct stability region may lack some votes due to ambiguous hyperplane pairs, it may nonetheless receive more votes than any other region.

#### 3.0 **EFAGHY Computer Program**

EFAGHY is an acronym for "Empirical Flutter Analysis by GALACTIC Hyperplanes." This is a Fortran77 program which has been running on the VAX4 computer and is designed to apply a file of hyperplanes produced by GALACTIC to files of test points so as to determine in which stability region each test point is located.

#### 3.1 Hyperplane File from GALACTIC

The file, called FILEHO within EFAGHY, was produced by GALACTIC and has the format, for each hyperplane:

Stability code for 1st stability region Stability code for 2nd stability region

C' Left hand side constant for 1st stability region

C" Left hand side constant for 2nd stability region

C<sub>1</sub> Right hand side coefficient for 1st variable

 ${\bf C_2}$  Right hand side coefficient for 2nd variable

•

The pair of parallel hyperplanes have the equations

$$c' = c_1 x_1 + c_2 x_2 + \dots$$

and

$$c'' = c_1 x_1 + c_2 x_2 + \dots$$

For a given test point, the right hand side is computed for the values  $\mathbf{x}_i$  which occur at the test point.

If c' is less than or equal the right-hand side, the first stability region claims the point while if c" exceeds or equals

the right-hand side, the second stability region claims the point.

If C' is less than C" the regions overlap and both regions can claim the point.

If C'exceeds C" there is a gap between the planes so that a test point which falls in the gap is not clearly claimed by either region.

Note that there is a coefficient for each of the words in the record for each test point. In the application of GALACTIC to the Annular Cascade Data Base, there are 20 words for each data point. The same 20 word format is used for test points employed by GALACTIC to build the hyperplanes as well as test points to which EFAGHY applies the hyperplanes. The words which are not relevant are multiplied by a zero coefficient.

### 3.2 Test Point Files to which Hyperplanes are Applied

EFAGHY is presently dimensioned to accept up to 14 files of test points. The words per test point record is also input, but must be the same as was used in GALACTIC, in which 20 was used.

#### 3.3 Input to EFAGHY

In addition to the number and names of files of test points and the length of their records and the name of the hyperplane file, EFAGHY asks the name for a file on which to write its output. If the response is null, then the output is printed on the user's terminal device.

Other input allows the input data points to be perturbed a fractional amount both plus and minus in any variable. The amount may be different for each variable.

It is also possible to confine the application of EFAGHY to certain hyperplanes, which must be named by the number in sequence in which they appear on the hyperplane file.

Finally, the output volume is controlled by a 7-digit number IOUTPUT consisting of O's and 1's. The O calls for suppression of an output, and 1 calls for display of output. The various possible output can best be explained in the course of describing the program capability.

#### 3.4 <u>Voting by Hyperplanes</u>

As described earlier there are 14 possible stability regions considered currently by GALACTIC. Between each pair of regions GALACTIC seeks to put a pair of parallel hyperplanes. As the number of pairs among 14 things is 91, there are 91 pairs of hyperplanes. Each pair is intended to separate one stability region from a second stability region.

For a given test point and a given hyperplane, the test point will be situated in one of the three domains into which the pair of hyperplanes divides all of space.

If the point is not situated between the pair of hyperplanes, the point occupies the same half space which contains one of the two stability regions. Thus this pair of hyperplanes indicates that the point has met a necessary (not sufficient) condition for being in one stability region and not being in the other. In this case, the pair of hyperplanes applied to the test point casts a yes vote for one stability region and a no vote for the other.

If, on the other hand, the test point is situated between the pair of hyperplanes, the situation is ambiguous. In case of overlap, it is possible to cast a vote for both, that is, to cast a fractional vote for each region depending on how deep into each region the point is, being 1 or yes for a stability region if on the plane bounding the half space belonging to that region and -1 or no if on the other plane. Thus the vote for each region varies linearly from +1 to -1.

In the case of a gap, the situation is also ambiguous. As with overlap, it is possible to cast a fractional vote for each stability region. If the point is virtually at one plane, a + 1 vote is cast for the stability region it bounds and -1 for the other region. The votes can vary linearly across the gap.

Now each stability region is voted on by 13 hyperplanes. Thus it can get a maximum of 13 yes votes. Since for each such vote, a different one of the other 13 stability regions receives a no vote, it follows that at most one stability region can receive 13 yes votes.

Other stability regions will receive some yes votes. But these should not be regarded as incorrect votes, since a yes vote simply means that the test point satisfies one of the 13 necessary conditions required of points in a particular stability region. A given test point will partially fulfill the requirements for several different stability regions, but it can fulfill all conditions for only one stability region.

Ideally it would be sufficient simply to count the yes votes to determine into which stability region the hyperplanes classified a point. Were there no ambiguous regions between the planes, there would be 91 yes and 91 no votes distributed among 14 stability regions, so that the average number of yes votes would be 6.5 per stability region. Because of the occurrence of ambiguous overlap or gap regions, there can be fewer yes votes. "Y" vote is the term that will be used for the

simple procedure of assigning a point to the stability region which has received the most yes votes, that is not counting no votes, overlap or gap votes.

A somewhat more complicated voting procedure is to give each stability region credit for any overlap or gap region adjacent to a half space belonging to the stability region. No votes are subtracted. This combined vote will be termed a "C" vote.

Another way of combining votes is the weighted vote, or "W" vote. This adds the yes votes, subtracts the no votes and treats the overlap or gap cases as follows. For these cases, the adjacent stability region gets a 1 vote if the test point is on the plane which bounds it, but the vote declines linearly as the test point is further across the overlap region, reaching 0 on the far plane.

A fourth way is the balanced vote, or "B" vote. This is similar to the W vote except that the vote goes from +1 to -1 in the overlap or gap cases rather than from +1 to 0.

A fifth, and final way is the probabilistic or P vote. This is like the B vote except that each vote is multiplied by the probability of an accurate vote for the stability region and by the hyperplane. This is gotten by first applying all hyperplanes to all data base points used to generate the hyperplanes and counting how many points which were in the stability region were correctly identified. Since in some cases there were very few points in a stability region, this observed success ratio was replaced by the lower 50 percent confidence bound for a binomial distribution. If there are many points the confidence band is narrow, while if there are few points it is broad. The final vote for a stability region is then normalized by dividing by the sum of the probabilities used in its calculation.

#### 3.5 Comparison of Vote Count Efficiency

The five different ways of counting votes were in fact developed in the order presented above, by evaluation against the test points from the Annular Cascade Data Base which had been used in producing the hyperplanes.

This information is available from EFAGHY in considerable detail. If the 7th digit of the output control IOUTPUT is 1 rather than 0, then the user is asked to enter up to 20 test points for the following output, the test points being numbered by the order in which they are encountered by EFAGHY. The output has on the left margin the hyperplane number () through 91) and the stability code for the first stability region: while on the right margin is the stability code for the second stability region. Between these are 5 columns. In the second and fourth columns are the lesser and the greater of the constants for the two stability regions. Bracketing these two constants are parentheses, like ( ), in case the stability regions overlap, or parentheses, like) (in case there is a gap between the two stability regions. The actual right-hand side value for the test point in question and the hyperplane is shown in the first, third or fifth columns depending on whether it is less than the two constants, whether it lies between them or whether it exceeds them. If the right-hand side is in the left, or first, column the hyperplanes vote that the point is in the stability region listed on the left margin; conversely for the right.

This highly detailed output allows the user to examine how each individual vote was cast. It allows us to examine why a test point known to be in a certain stability region is not getting the votes it deserves; and why some other stability region is getting more votes than it deserves. Perhaps one or another hyperplane is repeatedly casting wrong votes. Such a hyperplane may need to be recalculated using nonlinear combination variables.

The success for each hyperplane is summarized in a table entitled "Discrimination Success by Hyperplane," which is printed if the sixth

digit of IOUTPUT is 1. This shows for each hyperplane and for both its stability regions the number of yes, no, overlap and gap votes for each point known to be in either region.

If the third digit of the output control IOUTPUT is 1 rather than 0 then a table is printed out for each test point to which the hyperplanes are applied. The table has a row for each stability region and shows the number of yes, no, overlap and gap votes the greatest fractional penetration into a gap or overlap region, as well as the count of C votes, W votes, B votes, P votes. An asterisk marks the maximum vote of each of the five types.

Summary information for all files of test points is provided if the 4th digit of OUTPUT is 1. First there is a separate table entitled "Placement of Identified Sets," for each file, showing for each of the five types of votes how many times the correct stability region, when it was known, was in first place without ties, in the first place with ties, in the 2nd, 3rd place. Another table entitled "Discrimination Success by Set, Using B Votes" shows for each stability region the number of test points for which the stability region is known and there were 0, 1, 2,...stability regions with more B votes. Another table presents the same information but for P votes. This information is summarized still further in a tally of the number of test points for which the P and B votes agree in giving the most votes to the correct stability region, when one does, but not the other, etc.

#### 3.6 <u>Mixed Voting Strategies</u>

Application of the hyperplanes to the test points from the Annular Cascade Data Base from which it was constructed revealed that the P vote and the B vote were more successful than the other three voting procedures in identifying correctly the stability region in which the test points were located.

When both the B vote and the P vote identified the same stability region there was a still higher success rate.

Thus it seemed that in case the stability region was not known, the stability region should be chosen for which both the B vote and P vote agreed. But if they did not agree, what was to be done? Various strategies were evaluated. Here  $B_1$ , means the set with most B votes,  $B_2$  the set with second most B votes. Similarly for P.

Choose set with  $B_1 = P_1$ , else no choice

Choose set with  $B_1$ Choose set with  $P_1$ Choose set with  $B_1 = P_1$ , else with  $B_2 = P_2$ , else no choice

Choose set with  $B_1 = P_1$ , else  $B_2 = P_2$ , else  $B_2 = P_1$ , else  $B_1 = P_2$ , else no choice

Choose set with  $B_1 = P_1$ , else  $B_2 = P_1$ , else  $B_1 = P_2$ , else  $B_2 = P_2$ , else  $P_1$ Choose set with  $B_1 = P_1$ , else  $B_1 = P_2$ , else  $B_2 = P_1$ , else  $B_2 = P_2$  else  $P_1$ Choose set with  $B_1 = P_1$ , else  $B_1 = P_2$ , else no choice

Choose set with  $B_1 = P_1$ , else  $B_1 = P_2$ , else  $B_1$ .

For each strategy is supplied a table showing the number of test points for each chosen stability region and for each actual stability region. For perfect success, all off-diagonal entries would be zero. In addition, the probability of success is shown for each chosen stability region, and for all chosen stability regions. This is computed from the observed success rate converted by binomial theory to a 50 percent lower confidence level. The latter recognizes the uncertainty arising from small samples. This probability information by stability region is intended to detect whether some stability regions, when chosen by a certain strategy, deserve more confidence than others.

This information is presented if the sixth digit of IOUTPUT is 1.

#### 3.7 Summary of Output Options

As mentioned earlier, one of the input quantities is a seven-digit word, IOUTPUT, whose digits are 0 or 1, where 0 indicates supression of output and 1 indicates display of output.

As a memory aid, EFAGHY reminds the user of the function of each digit by use of a three-letter code, for which the details have been supplied in the foregoing text.

The seven codes and their abbreviated meaning are as follows:

<u>Digit</u>	Code	Principal Output
1	НҮР	Equations of the hyperplanes
2	PTS	Record (20 words) for each data point
3	VOT	Y, C, W, B, P votes for each stability region for each test point
4	ASS	Assessment of voting success per stability region
5	ASP	Assessment of voting success per point
6	ASC	Assessment of voting success per combined vote strategy
7	HPT	Voting per hyperplane for selected points

#### 4.0 EFAGHY Applied to Annular Cascade Data Base

EFAGHY was first applied to the test points from the Annular Cascade Data Base which were used by GALACTIC to generate the 91 hyperplanes. This was done because the stability region to which each of these points belonged was known. This would serve to calibrate the accuracy of EFAGHY, in three respects before it was applied to the Validation Points.

First it would show to what extent the voting by several hyperplanes could compensate for the fact that some hyperplanes were quite unsuccessful in discriminating between its two stability regions, classifying most points in its two stability regions into the amibguous overlap category. (As noted elsewhere, this deficiency in some hyperplanes may perhaps be remedied by inclusion of nonlinear combination variables).

Second it would allow for the evaluation of the different ways of counting votes and of the mixed voting strategies.

Thirdly the experience with the Data Base would provide a standard of success against which to appraise the application of the hyperplanes to the validation points, whose stability region was not disclosed beforehand.

#### 4.1 Detailed Examination of 26 Points from File 55777B

This was the first file of test points from the Annular Cascade Data Base, for which the stability region was known, and to which the hyperplanes were applied by EFAGHY. This file was chosen simply because it was the smallest.

Using the Y, C, W votes initially and later the B and P votes, we found that about 77 percent of these test points were assigned by the hyperplanes to the stability region to which GALACTIC had been told they belonged. These points included 12 stable points, 2 stall flex flutter and 6 choke flex flutter points.

Upon examination of the aeromechanical data for each of the remaining six points, we found that the stability region assigned by EFAGHY was actually even more correct in a practical sense. In the case of 3 test points the listed stability condition coexisted with the stability condition selected by EFAGHY and was given the second highest number of votes.

In the case of the other 3 test points, the stability region with the most votes prevailed very near to the test point and in the two cases the listed stability condition had the second highest number of votes, while in one case it received 9.2 the fourth highest number of votes with the regions with more votes: 12.2, 11.4, 11.0 all prevailing near the test point.

Thus from the point of view of practical use it may be said that 100 percent rather than 77 percent of the votes were correct.

It may however be asked, how it can happen that the hyperplanes do not score perfectly on reproducing the listed stability conditions since this information was available to GALACTIC when it was constructing the hyperplanes.

One reason is that for some pairs of stability regions, it is not possible to separate one region from the other by use of a (multi- dimensional) plane. In such cases, it may be that separation would be possible using nonlinear combinations of the given input variables. It may be of course that other variables beyond those currently used may be needed.

In such cases GALACTIC will necessarily produce discriminating planes with an overlap region between them and containing test points which the hyperplanes cannot assign to either region. For about 21 hyperplanes, most of the test points which they are intended to separate, fall into the ambiguous overlap region. Such planes may have poor reliability also with respect to orientation.

When used by EFAGHY, such hyperplanes can be doubly misleading since not only do the points in either of the two stability regions receive at best a weak overlap vote, but points which actually are not in either of the two regions may receive a yes vote due to the unreliability of such planes. While the P vote was introduced to limit the impact of such hyperplanes, it cannot compensate for the advantage to a stability region which is runner up not to be burdened with weak, unreliable hyperplanes.

Besides this reason, for some hyperplanes there are test points in the stability regions to be separated, which are placed not in the ambiguous overlap region but actually in the region belonging to the incorrect stability condition. This has occurred in a relatively few cases. The test point data have undergone considerable transformation before it emerges as an equation of a hyperplane pair and thus some points may violate the hyperplanes which they generated. In recognition of this, GALACTIC adjusts the hyperplane position, not the orientation so as to eliminate borderline violations, but limits the amount of adjustment. We need to verify the cause of such violations.

#### 4.2 <u>Detailed Examination of 57 Points from File C2BDY</u>

For these points, 51 percent were assigned by EFAGHY with the listed stability condition. But using the detailed aeromechanical data for each of the missed points, we found that the stability condition chosen by EFAGHY

coexisted at 6 points and that for 4 others the chosen stability region was close. One point was off the stability map and is regarded as somewhat anomalous; accordingly it was simply excluded.

This results in 39 hits in 56 points or 70 percent success rate.

For the remaining 17 points, only 3 are regarded as bad misses since EFAGHY gave the correct answer the third or fourth highest number of votes. Thus no hint of the correct answer was provided in 5 percent of the cases.

#### 4.3 Generic Examination of Data Base

The detailed examination of 85 data points as described above resulted in the fine tuning of the type of voting and of mixed voting strategies which would produce the greatest number of correct choices of stability region by EFAGHY.

The best method seems to be the P vote, that is to choose  $P_1$ , the stability region with the most P votes. Nearly as good is to choose  $B_1$ , the stability region with the most B votes. When these two agree, there is still greater likelihood of a correct answer. However, the  $P_2$  and  $B_2$  stability regions should also be considered since when the  $P_1$  or  $B_1$  choices are incorrect, it is very often the case that the correct, listed stability region was second choice. This was the case in the preceeding detailed examination of 85 data points, where the listed region was sometimes second choice with the most votes going to a coexisting region or a very near region.

For the 891 data points from the Annular Cascade Data Base which were used by GALACTIC to generate the hyperplanes and which included the 85 data points, it was not possible to carry out the detailed examination as was done on the 85 data points. Thus the only question that could be asked is whether the listed stability condition was chosen.

For 84 percent of the 891 data points the listed stability condition was among  $B_1$ ,  $B_2$ ,  $P_1$ ,  $P_2$ .

For 74 percent of the points,  $B_1$  and  $P_1$  agreed and when this occurred 87 percent of the time the choice was correct. If it is acceptable to refrain from a choice when  $B_1$  and  $P_1$  do not agree, a success rate of 87 percent is therefore indicated.

However if it is always required to make a choice, the best strategy seems to be  $P_1$ , which has a 59 percent success rate. The next best strategy seems to be  $B_1$ , which has a success rate of 56 percent.

Detailed examination of the 26 points, from File 55777B resulted in raising the 77 percent success rate for literal correctness to 100 percent for practical correctness, a jump of 23 percent. For the 57 points of File C2BDY raised the 51 percent success rate for literal correctness to 70 percent for practical correctness. Combined, the success rate for literal correctness was 59 percent, whereas detailed examination raised the success rate for practical correctness to 79 percent a jump of 20 points.

For the 891 test points,  $P_1$  choice also gave a success rate of exactly 59 percent for literal correctness. Were a detailed examination made of the aeromechanical situation of the missed points, it would therefore not be surprising if a success rate of 79 percent were achieved for practical correctness.

In view of the fact that only about 74 percent of the hyperplane pairs are fully adequate, it would not be surprising if only 79 percent of the test points were correctly classified. If non-linear terms could raise to near 100 percent the number of discriminating surface pairs, then a comparable improvement in the success rate is anticipated.

#### 5.0 Selection of Validation Points

#### 5.1 Types of Test Points Proposed

The technical proposal for this contract specified that the Validation test points would include data from fan and compressor stages of advanced military engines, commercial engines, and development engines and that the stability regions would include the stall and choke flutter boundaries, the stable operating regions and the stall and choke regions. The number of Validation Points was not specified.

#### 5.2 Actual Test Points Selected

A total of 51 test points were selected. These were distributed among seven sets of test data, as follows

			Sta	bility	Code		
	00	01	02	03	07	10	Total
Aeromechanical Compressor/ High Aspect Ratio		2	4				6
Development Fighter Engine Case 1 Fan Rotor 1st Stage	2	5					7
Development Fighter Engine Case 2 Fan Rotor 2nd Stage	1	4					5
Development Fighter Engine Case 3  Compressor Rotor Stage 4	3	3					6
High Bypass Turbofan Engine 20" Simulator	3	2			2		7
Rotating Rig Test		4	4	1		6	15
High Bypass Turbofan Engine	3	2					5
	12	22	8	1	2	6	51

The stability codes at the head of the columns have the meaning:

00 Stall; stable

Ol Stall; flexural flutter

02 Stall; torsional flutter

03 Stall; flexural and torsional flutter

07 Stall; separated flow

10 Interior; stable

We had intended to include some choke points from J85 data. However, we found on closer examination of the data, that choke and stall occurs simultaneously, the former at mid span and the latter at tip. Thus clear Validation Points are not available for choke. Accordingly no Validation Points of choke type were included.

#### 5.3 Aeromechanical Information per Test Point

In contrast to the Annular Cascade Data Base, for which the test points were richly instrumented and measured with special care, the Validation Points come from a non-research environment for which less information was available and what information was available had less precision.

The aeromechanical information which was generally available for production engines, to which this contract work is addressed consists of the following:

Word #	<u>Name</u>	<u>Meaning</u>
2	PIN	Pressure at inlet
3	TINLET	Temperature at inlet
6	SLDTYQ	Solidity
9	REY	Reynold's number
10	INC	Leading edge angle of incidence
11	MLE	Mach number at leading edge
14	VLE875	Velocity at a point on the leading edge distant from the blade root by 87.5% of the span
15	REDV1	Reduced velocity - flexure
16	REDV2	Reduced velocity - torsion

The word number denotes where the data occurs in the 20-word record used for each test point; the same format being used both for points from the Annular Cascade Data Base as well as for the Validation Points.

In anticipation of the limited amount of information available for the Validation Points, it was necessary for GALACTIC to use no more than that information from the much richer Annular Cascade Data Base in generating hyperplanes. Otherwise the hyperplanes, though doubtlessly more correct, would have been inapplicable to real world engine data. Indeed this restriction on the aeromechanical data that could be used might be one of the causes of some hyperplane pairs with heavily populated overlap regions wherein discrimination between the two stability regions was not possible.

#### 6.0 Application of EFAGHY to Validation Points

Once GALACTIC had produced 91 pairs of hyperplanes, these were applied to the 891 test points from which the hyperplanes had been constructed, thereby developing the voting system contained in EFAGHY. We found that 59 percent of the test points were correctly identified in a narrow literal sense by the hyperplane/voting system, and there is reason to believe that 79 percent of the test points were correctly identified in a broader practical sense. This is not surprising since only 74 percent (67 of 91) of the hyperplanes were fully adequate, some 21 of the stability region pairs showing intersections which might be avoided by curved discriminating surfaces and 3 requiring improvement.

We further found that while the best two voting approaches were to choose  $P_1$  or  $B_1$  (the top vote getters for P votes or B votes), giving the mentioned 59 percent literal accuracy, if both approaches agreed ( $P_1 = B_1$ ) then there was an 87 percent probability of the choice being correct in a literal sense.

Finally we found it was 84 percent certain that the correct stability region would be  $P_1$  the region with most P votes or  $P_2$  the runner up, or  $B_1$  the region with most B votes, or  $B_2$  the runner up.

EFAGHY was then applied to the 51 Validation Points. The results will be compared with those achieved when EFAGHY was applied to the 891 test points from the Annular Cascade Data Base.

The results can best be presented in two tables. The first table shows for each test point the codes chosen as  $B_1$ ,  $B_2$ ,  $P_1$  or  $P_2$  by EFAGHY together with the number of votes each code received. The greatest number of votes is marked with a prime (') and the second greatest is marked with a double prime (''). Columns are marked with an X to signal that the stability condition that actually prevailed was among  $B_1$ ,  $B_2$ ,  $P_1$  or  $P_2$ , that it was  $B_1$ , that it was  $P_1$ , that  $B_1$  and  $B_1$  agreed irrespective of whether they were correct.

# Aeromechanical Compressor/High Aspect Ratio

Daint	Correct	مو	TACUV OL	-4	X if Correct Co	ode i	<u>s</u>	v :6
Point	Stability		FAGHY Ch		Among			Xif
Number	Code	Code	B vote	P vote	$B_1, B_2, P_1, P_2$	В <sub>1</sub>	P <sub>1</sub>	$B_1 = P_1$
1	01	01	9'	5.7"	X	Х		
		03	6.5"	6.8'				
2	01	00	9'	7'	X	Χ	χ	Х
		01	91	5.7				
		03	5"	5.9"				
3	02	00	7"	5				
		01	9'	5.7"				
		03	5	5.9'				
4	02	00	7'	5"				
		01	7'	3.9				
		03	5"	5.91				
5	02	00	7.4"	5.2				
		01	8.41	5.7"				
		03	5.0	5.9'				
		07	7	5.9"				
6	02	00	7.5"	5.2"				Х
		07	91	7.61				

# Development Fighter Engine. Case 1. Fan Rotor, 1st Stage

	Correct	EFAGHY_Choice			X if Correct Code is Among X		
Point	Stability				<del>-</del>	R 0	X if
Number	Code	Code	B vote	P vote	$B_{1}, B_{2}, P_{1}, P_{2}$	B P 1	B <sub>1</sub> = P <sub>1</sub>
1	00	00	3'	4.9"	X		X
		01	7"	4.0			
		03	9'	7.1'			
2	00	00	5	6.8"	X		X
		01	7 <b>"</b>	4.0			
		03	9'	7.1'			
3	01	00	5	6.8"	X		X
		01	7"	4.0			
		03	9'	7.1'			
4	01	00	5	6.8"	X		X
		01	7"	4.0			
		03	9'	7.1'			
14	01	00	5	6.8"	X		X
		01	7	4.0			
		03	9'	7.1'			
23	01	00	5	6.8"	X		X
		01	7"	4.0			
		03	9'	7.1'			
27	01	00	5	6.8"	X		X
		01	7"	4.0			·
		03	9'	7.1'			

# Development Fighter Engine, Case 2, Fan Rotor, 2nd Stage

	Correct				X if Correct Co	ode i	S	
Point	Stability	E	FAGHY Ch	oice	Among			X if
Number	Code	Code	B vote	P vote	$B_1, B_2, P_1, P_2$	В <sub>1</sub>	P <sub>1</sub>	$B_1 = P_1$
<u>_</u> _						_		
1	01	00	5"	6.8'	X			
		01	5"	2.2				
		03	7'	5.4"				
2	01	00	3	6.81	X			
		01	5"	2.2				
		03	7'	5.4"				
3	01	00	3	4.9"	X			Χ
		01	5"	2.2				
		03	7'	5.4'				
4	01	00	3	4.9"	X	Χ	Χ	X
		01	7'	4				
		03	7'	5.4'				
		10	5"	0.7				
5	00	00	5.2"	6.8'	X		Χ	
		05	8.7'	2.9				

## Development Fighter Engine. Case 3. Compressor Rotor

	Correct				X if Correct Code is				
Point	Stability		FAGHY Ch		Among	Xif			
Number	Code	Code	B vote	P vote	B <sub>1</sub> , B <sub>2</sub> , P <sub>1</sub> , P <sub>3</sub>	2 B <sub>1</sub> P <sub>1</sub>	B <sub>1</sub> = P <sub>1</sub>		
41	00	00	3	4.9"	X		X		
		01	5"	2.2					
		03	9'	7.1'					
		22	5"	4.7					
42	01	00	3	4.9"	X		Χ		
		01	5"	2.2					
		03	9 '	7.1'					
		22	5"	4.7					
48	00	01	5"	2.2			Х		
		03	9'	7.1'					
	•	20	5"	6.6"					
49	01	00	3	4.9"	X		Х		
		01	5"	2.2					
		03	91	7.1'					
52	00	01	5"	2.2			Χ		
		03	91	7.1'					
		20	5"	6.6"					
53	01	00	3	4.9"	X		Х		
		01	5"	2.2					
		02	5"	4.1					
		03	91	7.1					
		05	5"	2.8					

# High Bypass Turbofan Engine. 20" Smaller

	Correct				X if Correct Code is						
Point	Stability	<u> </u>	FAGHY Ch	oice	Among			Xif			
Number	Code	Code	B vote	P vote	B <sub>1</sub> , B <sub>2</sub>	. P <sub>1</sub> , P <sub>2</sub>	B <sub>1</sub>	P <sub>1</sub>	$B_1 = P_1$		
				<del></del>			_	_			
1	07	02	8.6"	6.3"							
		03	7.3	7.0'							
		05	9'	3.0							
2	07	02	7.5'	6.1"							
		03	6.6	6.4'							
		05	7.0"	2.8							
3	00	03	8.5"	7.1'							
		10	8.91	5.6"							
4	01	03	8.41	7.1'					Х		
		10	8.3"	4.7"							
5	01	01	6.0	3.6"	Х				Х		
		02	4.1	3.6"							
		03	8.71	7.1'							
		10	6.9"	3.0							
6	00	02	5.0	4.5"					Х		
		03	8.8	7.1'							
		10	6.9"	3.0							
7	00	01	7.0"	4.0					X		
		02	5.0	4.5"	•						
		03	8.6'	7.1'							
		20	5.0	4.5"							

# Rotating Rig Test

	Correct		X if Correct Code is					
Point	Stability	E	FAGHY Ch	oice	Among			X if
Number	Code	Code	B vote	P vote	B <sub>1</sub> , B <sub>2</sub> , P <sub>1</sub> ,	$P_2$ $B_1$	P <sub>1</sub>	$B_{1} = P_{1}$
54	02	00	5.5	6.9"				X
		03	8.5'	7.1'				
		10	8.4"	4.2				
79	02	00	5.5	6.9"				Х
		03	8.5'	7.1'				
		10	8.4"	4.2				
158	10	00	5.5	6.9"	X			Χ
		03	8.61	7.1'				
		10	8.4"	4.2				
56	02	00	5.5"	6.9"				Χ
		03	8.5'	7.1'				
		10	8.5'	4.2				
89	02	00	5.5"	6.9				Χ
		03	8.51	7.1'				
		10	8.51	4.2				
179	10	00	5.3	6.9"	X			Χ
		03	8.71	7.1'				
		10	6.5"	2.3				
154	10	00	5.2	6.8"	X			Χ
		03	8.8'	7.1'				
		10	6.5"	2.3				
57	03	00	5.3	6.9"	X	X	Χ	X
		03	8.71	7.1'				
		10	6.6"	2.3				

## Rotating Rig Test

D 1. I	Correct	FFACILY Chaire			X if Correct Co	v ••	
Point	Stability	EFAGHY Cho			Among		Xif
Number	Code	Code	B vote	P vote	$B_1, B_2, P_1, P_2$	B <sub>1</sub> P <sub>1</sub>	$B_1 = P_1$
61	01	00	5.0	6.8'			
		03	7.01	5.4			
		10	6.8"	2.3			
		20	5.0	6.6"			
169	01	00	5.0	6.8"			
		03	7.0'	5.4			
		10	6.9"	2.3			
		20	5.5	6.9'			
176	10	00	5.0	6.8"	Χ		
		03	7.0'	5.4			
		10	6.9"	2.3			
		20	5.9	7.1'			
172	10	00	5.0	6.8"	X		
		03	7.0'	5.4			
		10	6.9"	2.3			
		20	5.9	7.1'			
63	01	00	5.0	6.8"			
		03	7'	5.4			
		10	7'	2.3			
		20	6.6"	7.6'			
148	01	00	5.1	6.8"	X		
		01	7'	4.0			
		03	6.9"	4.0			
		10	7'	7.5'			
		20	6.5	7.5'			
151	10	00	5	6.8"	X	X	
	-	03	7'	5.4	••	••	
		10	7'	2.3			
		20	6.7"	7.6'			
			J.,	,			

## High Bypass Turbofan Engine

Point	Correct Stability	EFAGHY Choice			X if Correct Co	X if	
Number	Code			P vote	B <sub>1</sub> , B <sub>2</sub> , P <sub>1</sub> , P <sub>2</sub>	B <sub>1</sub> P <sub>1</sub>	
	- <u> </u>						
92	01	01	5"	2.2	X		Х
		03	7'	5.4"			
		22	7'	6.1'			
93	01	00	5"	6.8"	X		X
		01	5"	2.2			
		03	9'	7.1'			
		10	5"	0.7			
94	00	00	3	4.9"	X		Х
		01	5"	2.2			
		03	7'	5.4'			
		22	5"	4.7			
95	00	00	5"	6.8"	X		Х
		01	5"	2.2			
		03	91	7.1'			
		22	5"	4.7			
96	00	00	5"	6.8"	X		X
		01	5"	2.2			
		03	91	7.1'			

For the Validation Points  $B_1$  was correct in a literal sense for only 5 points, 10 percent, and  $P_1$  for only 4 points, 8 percent. Furthermore the stability regions chosen as  $B_1$  or  $P_1$  for the other points have been reviewed and found were also not correct in any practical sense, that is the Validation Point is not in or near a transition to the regions chosen as  $B_1$  or  $P_1$ . These percents contrast to 59 percent for EFAGHY applied to the Annular Cascade Data Base.

For 67 percent of the points (34 of 51) the  $B_1$  and  $P_1$  choices agreed, but only 9 percent (3 of 34) were correct. Thus the agreement of  $B_1$  and  $P_1$  is no indicator of a correct answer. For the Data Base  $B_1$  and  $P_1$  agreed for 74 percent of the points and when this occurred their choice was correct for 87 percent of the cases.

For 61 percent of the points (31 of 51) the correct choice was among  $B_1$ ,  $B_2$ ,  $P_1$ ,  $P_2$ . This compares with 84 percent for the Data Base. The conclusion from the above would seem to be that although neither  $B_1$  nor  $P_1$  were proven useful as indicators of the correct stability region, the weaker result stands: that  $B_1$ ,  $B_2$ ,  $P_1$ ,  $P_2$  include the correct result for a fair percentage of the cases. This result would suggest that the hyperplanes have captured some of the reality of the Validation Points.

However even this mildly favorable conclusion seems to be unjustified as the following table shows.

The following table shows for each Validation Point the  $B_1$ ,  $B_2$ ,  $P_1$ ,  $P_2$  choices made by EFAGHY. The Validation Points having the same (correct) stability code are grouped together, without identification, but taken in the order used in the prior table.

Correct Code	00	B <sub>1</sub> , B <sub>2</sub> ,	P <sub>1</sub> or P <sub>2</sub>	Choice 03	es by EFA 05	GHY 07	10	20	22
00	X X X	X X		X X	x				×
	^	X X X	.,	X X X			X X	X	
01	X X X	X X X	X	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			X	X	X
	X X X X	X X X X		X X X					
	X	X X X X X X X X		X X X X X			x		X
		X X X	x x	X X X X	X		X X X	Y	^
02	X X X X	x		X X X X X			X X X	X X X	
	X X X X X X	X X X				X X	x		
03 07	X		X X	X X X	X X		X X X		
10	X X X X		^	X X X X X X X	۸		X X X X X	X X X	

The principal observation that can be made from the above table is that to the hyperplane/voting system in EFAGHY, the Validation Points all look similar in that the choice 00, 01 and 03 is made for almost every Validation Point. Since for 69% of the Validation Points, the correct choice is actually one of these three, it is to be expected by chance only that the correct choice would occasionally be made.

In fact, the response to certain groups of Validation Points is even more striking. The previous table, for example, shows that for all six Validation Points from the F101 Derivative Fighter Engine, Fan Rotor, 1st Stage the leading B and P scores are all almost identical. This similarity holds also for the lower scores for the other stability regions, not shown in the table.

There are seven such groupings of nearly identical votes for points. In all but one grouping, there is a diversity of actual stability condition. One possible explanation of the discrepancy between the hyperplane/voting system in EFAGHY as applied to the Annular Cascade Data Base and as applied to the Validation Points is that measurement of the nine aeromechanical variables in production engines is not as exact as in the Annular Cascade. To verify whether this was a factor, as well as to check for closeness to transition zones, the Validation Points were rerun with 18 variations, namely each of the 9 aeromechanical variables was perturbed + 10 percent. In most cases the  $B_1$ ,  $B_2$ ,  $P_1$ ,  $P_2$  choices by EFAGHY were the same as before. In hardly any case was the correct answer chosen.

Another possible explanation might be that the Validation Points covered too narrow a range relative to the 891 test points from the Annular Cascade Data Base, so that the Validation Points might all look alike. Alternatively, discrepancies might be explained if the range of the Validation Points exceeded that of the 891 points with many points having variables beyond the range of the 891 points.

The following table shows for the 51 Validation Points the maximum and minimum of each variable. The latter are then expressed relative to the corresponding maximum and minimum of the 891 points from the Annular Cascade Data Base, transformed to a scale from 0 to 1.

	PIN	INLET	SLDTYQ	REY	INC	MLE	VLE875	REDV1	REDV2
Point Number	2	_3	6	9	<u>10</u>	_11_	14	<u>15</u>	16
51 Validation	Points								
Max	49.3	868	1.63	47.4	17.1	1.334	1447	11.73	3.09
Min	16.3	535	0.81	6.73	3.45	0.424	472	2.61	0.64
51 Validation	Points	<u>. Relativ</u>	ve to Da	ta Base I	<u>Points</u>				
Max	0.54	0.87	0.83	2.42	0.71	0.71	0.64	1.24	0.26
Min	-0.25	0.002	-0.21	0.14	-0.03	0.06	0.05	0.16	0.01
891 Points Fr	om Data	Base							
Max	68.5	920.3	1.762	22.048	16.72	1.398	1658	9.693	9.93
Min	26.8	53.43	3 .974	4.19	-8.71	0.342	389	1.27	0.51

We can readily see that the range of the variables for the Validation Points is not small relative to the Data Base, but generally occupies a substantial portion within the range of the Data Base variables.

However inlet pressures for 65 percent (33 of 51) of the Validation Points are below the range of the 891 Data Base points; Reynold's numbers for 45 percent are above their Data Base range; solidity for 14% are below their Data Base range.

In fact there are only 4 points whose data all lie within the range of the 891 Data Base points, namely points 61, 169, 176, 172 from the Rotating Rig Test.

The possibility cannot therefore be discounted that the Validation Points do not fit the hyperplanes gotten from the 891 Data Base points because the Validation Points lie partially outside the range of the Data Base points. However the possibility loses some credibility since the hyperplanes do not fit the four Validation Points that lie within the range of the Data Base points any better than those that lie partially outside.

### 7.0 Resolution of Issues

As a result of the application of the hyperplanes produced by GALACTIC to the Annular Cascade Data Base as well as to validation points not in the data base a number of issues have surfaced. These will now be grouped under eight headings and discussed, together with a plan for the resolution of each issue.

### 7.1 Correctness of GALACTIC Hyperplanes

In the case of three hyperplane pairs (those that discriminate between stability regions 00 and 21, between regions 00 and 20, and between regions 10 and 23) the first discriminant method declared that the regions were disjoint even in subspaces of only 6 or 7 of the 9 aeromechanical variables. But the Relaxed Discriminant procedure for finding the discriminating planes was unable to do so even by using all 9 variables either for the overlap or gap case - at least within the 2000 allowed iterations. While the two discriminating methods have proven generally consistent, with allowance for numerical differences, these two cases raise the question of a possible bug in the code. The discrepant result in these two cases might however be due to the insufficient iteration or to numerical difference due to the complete diversity of the two methods. In these three cases the latest hyperplane produced was accepted by GALACTIC - which was, perhaps, not the best choice. But when GALACTIC and later EFAGHY tested two of these hyperplanes against the data points upon which they were constructed, we found that the majority of test points in one stability region was misclassified.

Whether there is an error in the coding or simply an inadequacy, it should be possible to improve the code so that not only in theory, but also in practice, a solution will always be found which, at worst, may place many points in an overlap region. Except for borderline cases, no points in the data base should be misclassified. It is believed, however, that this situation has impacted a relatively few hyperplanes and test points, and that the effect is further diluted in the voting process.

## 7.2 Nonlinear Discriminating Surfaces

While only a few hyperplanes misclassify very many data points from which they were generated, there are 21 which are ineffective in that they place in an ambiguous overlap zone a large number of the test points from which they were constructed. This is attributed to the inability of a plane to separate the two stability regions, a situation in which a curved surface is needed. Fortunately the existing linear code in GALACTIC can be utilized for this purpose, without change. If a nonlinear combination of the nine basic aeromechanical input variables can be suggested on physical grounds, it is an easy matter to enter this into one of the unused words in the 20-word record for each test point and redo certain of the hyperplanes using 10 instead of 9 aeromechanical variables.

The new combination variable might be a plausible flutter parameter, such as researchers have already explored, or it could be a second term in a mathematical expansion of a basic variable. In either case, this is an easily accomplished task which would not require modification of GALACTIC or EFAGHY and would be applied to only the 21 hyperplanes with heavily populated overlap region. It is however not clear how much experimentation with various nonlinear combinations might be required before finding suitable combination variables.

Note that GALACTIC provides little direct help in selecting nonlinear combination variables if the above choices prove inadequate. The testing of such variables, once conceived is however easy. One help that GALACTIC can offer in choosing the combination variables is the identification of clusters that contain, in close proximity, test points from more than one stability region. It can provide rotation of the test space so that the points can be viewed most advantageously. This would identify the linear combination of variables which are playing a key role, but it does not say how to combine these variables nonlinearly.

## 7.3 Additional Aeromechanical Variables

If we find that after introduction of nonlinear combination variables, certain pairs of stability regions are still not separable, it may be that separation requires use of other than the 9 aeromechanical variables currently employed.

One clear indication of this, even before experimentation with nonlinear combination variables, would be the occurrence of points of one stability region surrounded by points of another. Tools for analysis of clusters and convex hulls currently in GALACTIC would be helpful in this regard.

In such a situation an additional variable could perhaps lift the surrounded point out of its alien environment.

Were this the case, the practical conclusion would be that on production engines additional instrumentation is needed to supply the additional aeromechanical variables, if flutter prediction is required. The implication would be that past attempts to predict flutter empirically have been flawed by inadequate information.

Identification of additional necessary aeromechanical variables could be a major benefit from this effort.

#### 7.4 Data Base Selection

The 891 test points supplied to GALACTIC for construction of the hyperplanes were selected carefully from the thousands of test points in the Annular Cascade Data Base. The points were selected so as to define the transition zones from one stability region to another. If hyperplanes could be found to discriminate between these neighboring points, it seemed plausible that they would also discriminate between points remote from transition zones. Due to computer storage limitations, duration of runs and the cost thereof, it was important to construct the hyperplanes using as few test points as possible.

While the selection logic seems impeccable, it can be easily verified that the selected points are representative namely by applying the hyperplanes to the other points from the Annular Cascade Daia Base, those which were not used by GALACTIC to construct the hyperplanes.

This can be readily and cheaply done by EFAGHY since there is virtually no limit on the number of points to which the hyperplanes can be applied.

If we find that the hyperplanes correctly predict the stability region in which the new points are located, then this indicates a basic difference between the Annular Cascade Data Base and the real world Validation Points.

On the other hand, if we find that substantial numbers of the new points from the Annular Cascade Data Base are not correctly assigned, then this indicates that the data base selected for GALACTIC was not adequate.

Should the latter be the case, then the corrective action is clear, namely to include some or all of the incorrectly assigned points among the test points used by GALACTIC and to call upon GALACTIC to recalculate

the hyperplanes which discriminate the stability regions to which these points belong.

Hopefully the new hyperplanes would prove more effective both in classifying the test points of the Annular Cascade Data Base which would still not have been used by GALACTIC, as well as in classifying the Validation Points.

The only difficulty anticipated is that computer storage and running time limitations may be encountered if it is necessary to include many more data points in those stability regions which are already well populated.

### 7.5 Validity of the Validation Points

There is no question but that the data in the Annular Cascade Data Base are more precise than the real world Validation Points.

To determine if such inaccuracy could account for the incorrect classifications produced by the hyperplanes, the Validation Points were perturbed plus and minus 10 percent, in each of the nine variables individually, in the belief that this would include any possible inaccuracy in the data. The correct stability region was not chosen by EFAGHY in hardly any of the cases. Indeed the choice of stability region did not change very frequently.

While the perturbations were not done in all variables simultaneously, since this would entail  $2^9$  cases per test point, there is no indication that the correct answer would be chosen more frequently.

An alternate approach might however prove more efficient, namely to inquire how distant the Validation Point is from the nearest test point from its stability region which was used in the construction of the hyperplanes.

To do this would require some small amount of additional coding. But the basic information is already available, namely the distance of the point from each of the hyperplanes intended to bound the stability region to which the point in fact belongs.

### 7.6 Annular Cascade Data Base Applicability

The ultimate issue is of course the applicability of the Annular Cascade research vehicle to real world engine data.

If the hyperplane system of GALACTIC and EFAGHY works well on the test points from the Annular Cascade Data Base - particularly on test points which GALACTIC did not use - but poorly on the Validation Points, then the issue of artificiality of the Data Base becomes more compelling.

It would be possible to prove such incompatibility if we can show that Validation Points are surrounded by Annular Cascade test points belonging to a different stability region.

All of the foregoing work described in this section can be expected to improve the validity of the hyperplanes. Thus such work can only sharpen the issue of artificiality should the hyperplanes prove ultimately unable to correctly classify the Validation test points.

Should this prove to be the case, the new question arises as to a possible real world correction. Presumably there would be some parameter which had one value for the Annular Cascade and some different values for the Validation Points. There would be of course no clue in the Annular Cascade Data Base as to what this parameter might be as it would have been common to all the test points.

Discovery of such a parameter might arise from engineering reasoning, possibly from among the aeromechanical data recorded for the Annular Cascade but not for production engines. On the other hand, it might be

devised simply as an empirical correction that would shift the stability regions.

A third approach of course would be the incorporation of the current Validation Points into the data base used by GALACTIC, together with identification of new test points with which to validate the hyperplanes. It would be interesting to see which pairs of stability regions would admit hyperplanes which would be violated by neither the Annular Cascade Data Base, nor the Validation Points.

### 7.7 Implied Operational Map for Validation Points

If it were concluded after the various possible improvements were made, that the Annular Cascade Data Base is not compatible with the Validation Points, it would be possible by use of EFAGHY to construct the operational map for each set of Validation Points, as implied by the Annular Cascade Data Base. If such a map were at all reasonable, it might be that a relation between the actual and the implied map could be discovered. This could lead to a fundamental insight as to which aeromechanical variable requires correction, or an empirical correction.

#### 7.8 Combination Stability Regions

The stability regions as presently defined do not include global regions for example for stall, but only the subregions for the different sub types of stall, such as flexural, torsional etc.

It has been suggested that the hyperplanes might prove more effective if they addressed the question of separating, for example, stall from choke, flutter from stability. Only after this basic question was addressed, would the type of stall be investigated. Certainly the existing system can be used to discriminate between test points classified into any non-overlapping regions. But this would entail of course an independent set of hyperplanes, since it would not be possible to regard both generic stall and flexural stall in the same analysis as these regions overlap.

It would be worthwhile and inexpensive to try this idea. No new programming would be needed. The only problem would be the large number of test points that might need to be analyzed simultaneously. It is not clear now how limiting that problem might be.

#### 8.0 Conclusions

### 8.1 Methodology for Analysis of Large Data Bases

The principal conclusion is that a general purpose technology has been developed and implemented in checked out computer code for analysis of large data bases. While this was devised for application to the Annular Cascade Data Base for empirical prediction of flutter, the technology is general purpose, with much broader application.

The most important of these technological developments are

- Relaxed Discriminant Method for determining two parallel hyperplanes that separate two sets of points
- O Discriminant Feasibility Method to determine whether two sets of points are separable by a hyperplane
- o Stepping Stone Cluster Method to identify clusters using the two metrics: Euclidean and Stepping Stone, without need to quantify in advance what is meant by a small distance.
- o Hyperplane + Voting system to identify regions occupied by various groupings of like points. These regions can then be used to predict the grouping to which a new point would belong.

In addition there were several other developments: the Non-Objective Simplex Method, L1 eigenanalysis, and matrix techniques to determine the shape and size of groupings of points. These methods can be applied to other engineering problems, as well as related maintenance and supply problems, as well as to completely different data bases for example data bases concerned with personnel.

# 8.2 <u>Hyperplane/Voting System Applied to Annular Cascade Data Base</u>

The above GALACTIC/EFAGHY system has been applied successfully to 891 test points of the Annular Cascade Data Base.

For 83 of these test points whose aeromechanical situation was looked at closely, the system correctly identified the stability condition of 59 percent of the points in a narrow literal sense. But in a practical sense, 79 percent of the points were correctly identified.

When applied to the 891 test points, the system again correctly identified the stability condition of 59 percent of the points in a narrow literal sense. Since it was not possible to look closely at the aeromechanical situation of all of these points, it is not possible to say how many were correct in a broader practical sense. But since the 59 percent correctness in a literal sense agreed for both sample and population, it can be conjectured that the 79 percent correctness in a practical sense might apply not only to the sample but to the population as well.

These already favorable success ratios need to be placed in perspective. First, the test points to which the Hyperplane/Voting system was applied are the same test points used in constructing the system so that high success is to be expected. Second, only 76 percent of the hyperplanes are adequate without nonlinear variables; thus, there are various easily available steps using the existing Hyperplane/Voting system by which the success ratio can be increased further.

## 8.3 <u>Hyperplane/Voting System Applied to Validation Points</u>

The Hyperplane/Voting System applied to 51 Validation Points taken from seven sets of engine test data, was however, not successful in identifying the stability condition either in a narrow literal sense, nor in a broader practical sense.

# This raises questions:

- o whether the Annular Cascade Data Base is representative of real engine data
- o whether the 891 point sample used to construct the hyperplanes was representative of the full Annular Cascade Data Base.

Specific steps are proposed for resolving these questions, and for using the insights thus obtained to improve the predictive ability of the Hyperplane/Voting systems when applied to real engine data.

Appendix A - GALACTIC Listing

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C DO NOT PRINT OUT THE NUMBER OF WORDS ALLOCATED

IF (J.NE.10) WRITE(06.*)1024*J, WORDS ALLOCATED

IF (J.NE.10) WRITE(06.*)1024*J, WORDS ALLOCATED

IF (NVNLMAX.GE.2*NVMAX.AND.NVNLMAX.GE.20.AND.NVNLMAX.*2.GE.32.*

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WRITE(06.*)' PARAMETER ICLMAX=',ICLMAX,' BUT MUST BE AT LEAST
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B. 13, 119, 17, 858/
DATA (VARMMU(9, JJ), JJ=1, 6)/-8, 71, 16, 72, 6, 0870879, 4, 1214311
B. 4, 005, 25, 43/
DATA (VARMMU(10, JJ), JJ=1, 6)/-8, 71, 16, 72, 6, 0870849, 17107861
B. 1, 6755, 1, 531/
DATA (VARMMU(11, JJ), JJ=1, 6)/-91, 2, 441, 1, 3140142, 24496324
B. 1, 1, 26/
DATA (VARMMU(13, JJ), JJ=1, 6)/-02, 24, 10449291, 038614039
B. 11, 26/
DATA (VARMMU(13, JJ), JJ=1, 6)/389, 1658, 1607, 4842, 207, 07176
B. 1023, 5, 1269, 7
DATA (VARMMU(14, JJ), JJ=1, 6)/1, 27, 9, 693, 4, 7684722, 1, 3461923
B. 54815, 84, 423/ DATA (VARMMU(15,JJ),JJ=1,6)/.51,9.9299999,1.7055396,.51473065 DATA (VARMMU(16.JJ), JJ=1,6)/0.,5.,.39638713,1.1982756,2.5,5. BATA (VARMMU(2.JJ), JJ=1,6)/534.3,920.3,780.78507,132.25561 8,727.3,386./ DATA (VARMMU(3,JJ),JJ=1,6)/16.38,23.23,17.7359,2.4587139 8,16.805,12.85/ DATA (VARMMU(4,JJ),JJ=1,6)/-34,3.63,2.0190405,.63665905 8,1.645,3.97/ DATA (VARMMU(5,JJ),JJ=1,6)/-974,1.762,1.2189113,.21632369 8,1.368,.788/ DATA (VARMMULD,JJ),JJ=1,D)/393,,68.949,58.23621,4.8171529 8,54.1265,29.645/ DATA (VARMMU(7,JJ),JJ=1,6)/.344,1.457, 82604469,.1821D604 DATA (VARMMU(1,JJ),JJ=1,6)/26.8,68.5,51.649194,13.450007 IF(IMODE.EQ.0) CHMODE=CHBAT WKITE(06,150)DATE1,11ME1,CHMUDE FORMAT('RUN ON',A8, AT',F6.2, HOURS CALL DATIM(DATE: , IIME!) CALL PTIME(TIMEIN) 140 FORMAT(72(1H=)) CHTSH='TSHAREFILENAME=' IMODE-MODE(1) 120 WRITE(06,140) CHBAT= BATCH VBIGN0=1.E30 8,47.65,41.7/ WRITE(06,+) FILECR= ICASE=0 150

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8. OF "NFILE," FILES OFFERED.
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IF(IMODE.EQ.D) wRITE(06,*)NFILE, ' ', (FILIN(I), :1, MIND(NFILE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ISTAT=', ISTAT
                                                                                          READ(05,*)NFILE. (FILIN(1), 1=1, MINO(NFILE, NFILWAX-1)), INMAX
                                                                                                                                                                     &NFILMAX-1)),INMAA, CHCF
IF(NFILE.GT.NFILMAX-1) WRITE(06,*)' CAN ACCEPT ONLY FIRST'
&NFILMAX-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ISTAT=', ISTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ISTAT=', ISTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             . ISTAT=', ISTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ISTAT=', ISTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    OPEN(14,STATUS='SCRATCH',IOSTAT=ISTAT,

&ACCESS='SEQUENTIAL',FORM='UNFORMATTED')
OPEN(24,STATUS='SCRATCH',IOSTAT=ISTATI,
&ACCESS='SEQUENTIAL',FORM='UNFORMATTED')
IF (ISTATI NE.O .OR. ISTATI NE.O) THEN
WRITE(06,*) 'ERROR OPENING IFRONTR FILES.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    OPEN(13,STATUS='SCRATCH',IOSTAT=ISTAT,

&ACCESS='SEQUENTIAL',FORM='UNFORMATTED')

UPEN(23,STATUS='SCRATCH',IOSTAT=ISTAT),

&ACCESS='SEQUENTIAL',FORM='UNFORMATTED')

IF (ISTAT.NE.0 'OR' ISTATI.NE.0) THEN

WRITE(06,*) 'ERROR OPENING IDIST FILES.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ITEMP=NPMAX*NPMAX
OPEN(10,STATUS='SCRATCH',IOSTAT=1STAT,
&ACCESS='SEQUENTIAL',FORM='UNFORMATTED')
IF (ISTAT.NE.O) THEN
WRITE(06,*) 'ERROR OPENING XINF FILE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               OPEN(1), STATUS= SCRATCH', IOSTAT=ISTAT,
&ACCESS='SEQUENTIAL', FORM='UNFORMATTED')
IF (ISTAT NE 0) THEN
WRITE(06,*) 'ERROR OPENING EDIST FILE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          OPEN(15,STATUS= >CRATCH', IOSTAT=1STAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ISTAT1=', ISTAT1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ISTAT1=', ISTAT1
                CALL MESSAGE (2)
DO 155 K=1,NFILMAX
FILIN(K)=FILECR
                                                                                                                                                                                                                                                                                                                                                                                                                                                          I TEMPO=NPMAX*NVMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      STOP 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ST0P 3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      5T0P 4
                                                                                                                                                                                                                                                                                                                                                                                                                                   ISTAT=0
                                                                                                                                                                                                                                                                                                                               \circ \circ \circ \circ
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C IF MEMSIZ IS THE VAX DUMMY MEMSIZ ROUTINE THAT SIMPLY SETS J=10, C DO NOT PRINT OUT THE NUMBER OF WORDS ALLOCATED

IF (J.NE.10) WRITE(06.*)1024*J. WORDS ALLOCATED

WRITE(06.250)MINO(INMAX,NVMAX)

250 FORMAT('ENTER N (LE',14,'), THEN NAME N VARIABLES')

READ(05.*)NV,(IN(J),J=1,MINO(NVMAX,NV))

IF(IMODE.EQ.0)WRITE(06.*)NV,(IN(J),J=1,MINO(NVMAX,NV))

IF(NV,GT,NVMAX)WRITE(06.*)' ERROR. ACCEPTING ONLY FIRST',NVMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF(MAXJ.GT.INMAX)WRITE(UO,*) ERROR.INPUT FILE HAS ONLY.INMAX 8.' VARIABLES'
290 WRITE(06,*)' ENTER N (LE'.ISETMAX,') THEN ID OF N SETS TO BE 8. EXCLUDED'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    READ(05,*)NSETOUT, (ISETOUT(I), I=1, MINO(NSETOUT, ISETMAX))
IF(IMODE.EQ.0)WRITE(06,*)NSETOUT, (ISETOUT(I), I=1, MINO(NSETOUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IMPUSSIBLE INPUT INTERPRETED AS CUE TO RESTART RUN")
                                                                                                                                                                  295 FORMAT(' DATA IGNORED BEYOND DIMENSION LIMIT OF .14)
IF(NSETOUT.LT.O.AND.IMODE.EQ.1) GO TO 257
IF(NSETOUI.LT.O.AND.IMODE.EQ.0) STOP 11
CALL MESSAGE (4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (NSETOUT, GT. ISETMAX) WRITE (06, 295) ISETMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            8, VARIABLES.
CALL MESSAGE (3)
READ(05, *) ISETVAR
IF(IMODE.EQ.0) WRITE(Ub.*) ISETVAR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(NV.GT.0) GO TO 270
IF(IMODE.EQ.0) GO TO 259
WRITE(06.260)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        FORMAT(" IMPUSSIBLE INPUN-
NV=MINO(NV,NVMAX)
DO 275 J=1,NV
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            MAAL=MAXU(MAXL, IN(L))
                                                                                                                                                                                  210 DO 220 I=1, ISETMAX NPINSET(1)=0
                                                                                                                                                                                                                                                                                         DO 230 I=1,NPMAX
230 IPINSET(I)=0
                                                                                                                                                                                                                              ISETID(1)=18175
                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL MEMSIZ(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 280 J=1,NV
                                                                                                                                                                                                                                                    1 SETOUT(1)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               &. ISETMAX))
                                                                                                                                                                                                                                                                                                                                                                                           NSETOUT=0
NPTOUT=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   MAXU=IN(1)
                                                                                                                                                                                                                                                                                                                                       10uTPuT=0
                                                                                                                          STUP 5
                                                                                                                                                                                                                                                                     220 CONTINUE
                                                                                                                                                                                                                                                                                                                                                           IOUTPS=0
                                                                                                                                                                                                                                                                                                                                                                              10UTPC=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     STOP 10
                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         255
257
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       259
260
270
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TOTAL PROPERTY PROPERTY - RESERVENT PROPERTY PROPERTY OF REPRESENT PROPERTY OF RESERVENT PROPERTY OF P

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ISETNAM=0
C NPTEMP=# PTS READ, NPT=# PTS NOT EXCLUDED BY USER, NP=# ANALYZED
IF(NSETOUT.NE.O.OR.NPTOUT.NE.O) WRITE(O6,*)* ORIGINAL POINT
& NUMBERS FOR INCLUDED POINTS'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ITEMP=BUFFER(ISETVAR)
IF(NSETOUT.EQ.0.AND.NPTOUT.EQ.0.AND.NSETCOM.EQ.0) GO TO 335
IF(NSETOUT.LE.0) GO TO 325
DO 324 K=1,NSETOUT
IF(ITEMP.EQ.ISETOUT(k.)) GO TO 320
                                                          IF(NPTOUT.GT.20)WKITE(U6,295)20
IF(NPTOUT.LT.0.AND.IMODE.EQ.1) GO TO 257
IF(NPTOUT.LT.0.AND.IMODE.EQ.1) GO TO 257
IF(NPTOUT.LT.0.AND.IMODE.EQ.0) STOP 14
CALL MESSAGE (5)
READ(O5.*)NSTCOM, (ISETCOM(I),I=1,2*MINO(NSETCOM,ISETMAX))
IF(IMODE.EQ.0)
SWRITE(O6,*)NSETCOM, (ISETCOM(I),I=1,2*MINO(NSETCOM,ISETMAX))
READ(05,*)NPTOUT (IPTGUT(I),I=1,MINO(NPTOUT,20))
IF(IMODE.EQ.0)WRITE(06,*)NPTOUT,(IPTOUT(I),I=1,MINO(NPIOUT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(NSETCOM.LE.0) GO TO 332
DO 331 K=1,NSETCOM
IF(ITEMP.EQ.ISETCOM(2*K-1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             READ(U1, *, END=360) (BUFFER(L), L=1, INMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       VARMUM(J, 1) -AMINI(VARMUM(J, 1), TEMP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF(ISETVAR.GI.U) IPINSET(NP)=ITEMP
IF(ISETVAR.LE.O) IPINSET(NP)=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (NPTEMP. EQ. IPTOUT(K)) GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IfemPMV(ITEMPO)=NPTEMP
IF(ITEMPO_LT_15) GO TO 335
WRITE(OG,60)(ITEMPMV(J),J=1,15)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (NPT GT NPMAX) GO TO 336
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(NPTOUT.LE.0) GO TO 329
                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL ATFILE(FILIN,NFILE)
GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              XINF (NP.J) = BUFFER (IN(J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 310 VARMOM(J,4)=TEMP**2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 UG 34G J=1,NV
TEMP-BUFFER(IN(J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TEMP=BUFFER(IN(J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 327 K=1,NPTOUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              VARMOM(J,2)=TEMP
VARMOM(J,3)=TEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               VARMOM(J, 1)=TEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      I TEMPO = I TEMPO + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NPTEMP=NPTEMP+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 330 1=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 N. 1=L 015 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NFT-NPT+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                    NPTEMP=0
                                                                                                                                                                                                                                                                                                ITEMP0=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                I TEMPO=U
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NP-NP+1
                                                                                                                                                                                                                                                                                                                                                                                                              NFILE=1
                                                                                                                                                                                                                                                                         NPT=0
                                                                                                                                                                                                                               O=dN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             320
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325
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   3.36
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 331
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IF(ISETNAM.LE.ISETMAX) GO TO 400
WRITE(06,390)ISETNAM,ISETMAX
390 FORMAT(' NUMBE: OF SUBSETS IS GE',14,', EXCEEDS DIMENSION',14)
GO TO 9000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 GO TO 450
440 WRITE(Ub.*) ** NUMBER OF SUBSETS*, ISETNAM*1, ** EXCEEDS DIMENSION
                                                                                                                                                                                                                                                                                                                                                                                                         CALL AIFLE(FILIN, NFILE)

IF(NFILE.NE.0) GO TO 320

IF(NFILE.NE.0) GO TO 320

IF(NFILE.NE.0) WRITE(06.0U)(ITEMPNV(J), J=1, ITEMPO)

IF(NP.EQ.NPT) GO TO 359

WRITE(06.+)

WRITE(06.3493) 'SET ID (ISETID(I), I=1, ISETNAM)

WRITE(06.3493) 'SET ID (ISETID(I), I=1, ISETNAM)

WRITE(00.3493) 'PUINIS PER SET', (NPINSET(I), I=1, ISETNAM)

WRITE(00.+)

WRITE(00.+)

WRITE(00.+)
                                                                                                                                                                                                                           349 NPINSET(1)=NPINSET(1)+1
IF(NP.EQ.1) GO TO 300
IF(NPT.EQ.NPMAX+1) WRITE(06,350)NPMAX
350 FORMAT('WARNING. CAN ANALYZE ONLY FIRST',16,' POINTS.')
GO TO 320
                                                                                      IF(ISETNAM.EQ.0) GO TO 346
DO 345 I=1,ISETNAM
IF(BUFFER(ISETVAR).EQ.ISETID(I)) GO TO 349
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(IPINSET(I).EQ.IPINSET(J)) GO TO 380
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 430 I=2,NP
DO 410 J-1,1SETNAM
IF(ISETID(J).EQ IPINSET(I)) GO TO 420
VARMOM(J,2)=AMAXI(VARMOM(J,2),TEMP)
VARMOM(J,3)=VARMOM(J,3)+TEMP
VARMOM(J,4)=VARMOM(J,4)+TEMP++2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF(ISETNAM.GE.ISETMAX) GO TO 440
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NPINSET(J)=NPINSET(J)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ISETID(J)-IPINSET(I)
420 IPINSET(I)=J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ISETID(1)=IPINSET(1)
                                                                                                                                                              345 CONTINUE
346 ISETNAM=ISETNAM+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              I SETNAM= I SETNAM+ 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              I SETNAM= I SETNAM+ 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 380 1=2,NP
DO 370 J=1,I 1
                                                                                                                                                                                                                                                                                                                                                                                          360 NFILE=NFILE+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IPINSET(1)=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NPINSET(1)=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ISETID(I)=0
ISETNAM=1
                                                                                                                                                                                                             I = I SETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   400 ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   J=I SETNAM
                                                                       340 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                410 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         370 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         365
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            369
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IF(II.NE.O.AND.12.NE.O) GO TO 490
WRITE(06,*)' MUST USE ONLY LISTED OPTIONS. USED: ',CHTVP,''.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL MESSAGE (b,
DO 510 J=1,Nv
WRITE(DG,500)J.vARMOM(J.1).
&VARMOM(J,5).VARMOM(J,2),VARMOM(J,6),VARMOM(J,4).
510 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                     8 CHSCL

GO TO 470

490 IF(11.NE.7.AND.12.NE.7) GO TO 520

495 WRITE(GO.*) SUMMARY OF EACH VARIABLE FOR THE ,NPT, INPUT

8 DATA POINTS
                                    VARMOM(J,3)=VARMOM(J,3)/XNP
VARMOM(J,4)=VARMOM(J,4)/XNP-VARMOM(J,3)**2

IF(VARMOM(J,4),LT.U.)WRITE(O6,*)' CALCULATED VARIANCE IS
& NEGATIVE: VARMOM(J,4)' ABS VALUE USED IN SIGMA'
VARMOM(J,4)=SQRT(ABS(VARMOM(J,4)))
VARMOM(J,5)=(VARMOM(J,1)*VARMOM(J,2))/2.
VARMOM(J,6)=VARMOM(J,1)*VARMOM(J,1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE(06,*)' ENTER TYPICAL VALUES FOR THE'.NV,' VARIABLES'
READ(05,*)(STYP(I).I=1.NV)
IF(IMODE.EQ.0)WRITE(06,*)(STYP(I),I=1,NV)
IF(12.Eq.7) GO TO 570
IF(12.Eq.7) GO TO 570
IF(12.LT.7) SVAR(J)=VARMOM(J,I2)
IF(I2.LT.7) SVAR(J)=VARMOM(I)-1.I2-7)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE(06.+) ENTER SCALE VALUES FOR THE 'NV, VARIABLES' READ(05.+)(SVAR(1),I=1,NV)
IF(IMODE.EQ.0,"RITE(06.+)(SVAR(1),I=1,NV)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE(06,*)
IF(IDIGIT(10UTPUT,10MAX).NE.0) GO TO 640
FORMAT(14,E13.4,5E11.4)
IF(I1.EQ.7) GC TO 540
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF(I1.LT.7)STVP(J)=vARMOM(J.I1)
IF(I1.GT.7) STVP(J)=vARMMU(IN(J)-1,I1-7)
                                                                                                                                                                                                                        CALL MESSAGE (7)
READ(05,*)CHTVP, CHSCL
IF(IMODE.EQ.0)WRITE(06,*)CHTVP, CHSCL
DO 480 I=1,13
IF(CHTVP.EQ.CHVAR(I))I1=I
IF(CHTVP.EQ.CHVAR(I))I2=I
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ(05,*)NBOND
IF(IMODE.EQ.0)WRITE(06,*)NBOND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (NBOND, EQ. 0) JU TU 630
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 590 I=1, NPMAX
180ND(I)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL MESSAGE (9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     VN.1=L 068 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(06, +)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               GO TO 550
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             GO TO 580
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
45C XNP=NPT
                                                                                                                                                                                                                                                                                                                                                                    480
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     500
520
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     260
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          550
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  5/u
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       540
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   590
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```
IF(!UUTPUT.LT.U) GO TO 255
WRITE(06.*)' FOR SETDATA:IPT.MEM.DSJ.HPL.BAX.PRJ.BTR.CGR.COR.EST.
&HPP.HPO'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ(D5,*)IOUTPS
If(IMODE.EQ.O)WRITE(D6,*)IOUTPS
IF(IOUTPS.LT.O) GO TO 255
WRITE(06,*)' FOR CLUSTRS:EDS,SDS,STP,FPT,MEM,CCD,BAX,PRJ,BTR,CGR,
                                                                                                                                                                                                            605 IF(I.LE.NP.AND.J.LE.NP) GO TO 610
WRITE(06,*)' PAIR IGNORED SINCE I OR J EXCEEDS MAX PT NUMBER',NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE(06.*)''
WRITE(06.*)' DATA TRANSFORM TO NORMALIZED AXES (V) FROM ORIGINAL
& AXES (U)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ(05,+)10UTPC
IF(IMODE.EQ.0)WRITE(06,+)IOUTPC
IF(IOUTPC.LT.0) GO TO 255
IF(IDIGIT(10UTPUT,10MAX).EQ.0) GO TO 640
IF(MP.LT.NPT) WRITE(06,+)' FOR THE POINTS TO BE ANALYZED:'
                                                                                                                                                                                                                                                                                                                          I=I1
IF(1BOND(I).EQ.0.AND.1BOND(J).EQ.0) GO TO 620
WRITE(06.*)' PAIR IGNORED SINCE OVERLAP WITH A PRIOR PAIR'
GO TO 600
620 1BOND(I)=J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE(Ob.*) FINTER O OR 1 TO NOTWRITE,OR WRITE FOLLOWING 8 OUTPUT OPTIONS:
IF(NBOND.LT.0) GO TO 255
NBOND=MINO(NP.NBOND)
WRITE(O6.*)' ENTER THE',NBOND,' PAIRS OF POINT NUMBERS'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(06.*) FOR ALLDATA:SMN,NTR,NPT,BAX,BTR,BPT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SET ID
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(06,*)
WRITE(06,*)
NO.0F POINTS
DO 635 K=1, ISETNAM
WRITE(06,*)K, ISETID(K), NPINSET(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF(1MODE.EQ.U)WRITE(06,*)IOUTPUT
                                                                                            READ(05,*)1,J
IF(IMODE.EQ.0)WRITE(U6,*)1,J
IF(I.GT.0.AND.J.GT.0) GO TO 605
IF(IMODE.EQ.1) GO TO 129
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(SVAR(1):GE.G.)CHS(I)=CHP
IF(SVAR(1):LT.U.)CHS(I)=CHM
650 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF(K.LT.NBOND) GO TO 600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ(05, +) LOUTPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 650 I-1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE(06,*) '
                                                                                                                                                                                                                                                                             (L, 1)0NIM=11
                                                                                                                                                                                                                                                                                                      (L, I)0XAM=L
                                                                                                                                                                                                                                                         GO TO 600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IOMAX5=12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IOMAXC=12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         635 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             630 IOMAX=6
                                                                                                                                                                                                                                                                                 610
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660 CONTINUE.
670 FURMAT(A4, (',12,') = ',E11.4,A2,E11.4,'*',A2,'(',12,')')
WRITE(06,*)
WRITE(06,*)
WRITE(06,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             C COMPUTE EDIST MATRIX OF EUCLIDEAN DISTANCES BETWEEN POINTS, NPANP 750 IF(IDIGIT(100TPC, 10MAXC).NE.0) WRITE(06,*).

IF(IDIGIT(10UTPC, 10MAXC).NE.0)WRITE(06,*). MATRIX OF EUCLIDEAN 8 DISTANCES BETWEEN NORMALIZED POINTS.
                                                                                                                                                                                                                                                                                      WRITE(06.*)'
WRITE(06.*)'
WRITE(06.*)' NORMALIZED DATA POINTS, WITH POINT, SET NUMBER AT
& BEGINNING OF ROW'
710 DO 730 I=1 NP
DO 720 J=1,NV
WRITE(06,670)CHV.1.-STYP(1)/SVAR(1),CHS(1),ABS(1./SVAR(1)),
                                                                                                                                                                            #RITE(06,670)CHU,1,STYP(1),CHS(1),ABS(SVAR(1)),CHV,1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       33
55
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         1J=II+(JJ-1)*ISETNAM
JI=JJ+(II-1)*ISETNAM
BUFFER(J)=0.
BUFFER(J)=BUFFER(J)+(XINF(I,K)-XINF(J,K))**2
BUFFER(J)=BUFFER(J)
                                                                                                                                                                                                                                                                                                                                                                                                                               72U CONTINUE
WRITE(10,ERR-740)(XINF(1,J),J=1,NV)
IF(1DIGIT(10UTPUT,IOMAX-2).EQ.0) GO TO 730
WRITE(06,75)1.IPINSET(1) (XINF(1,J),J=1,NV)
                                                                                                                                                                                                                                              700 CGTOT(J)=(VARMOM(J,3)-STVP(J))/SVAR(J)
IF(IDIGIT(IOUTPUT,IOMAX-2).EQ.0) GO TO 710
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SDISTMX=AMAX1(SDISTMX,BUFFER(J))
IF(TEMPMV(IJ).EQ.-1) GO TO 765
IF(TEMPMV(IJ).LT.BUFFER(J).AND.II.EQ.JJ)
IF(TEMPMV(IJ).GT.BUFFER(J).AND.II.NE.JJ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GO TO 756
740 WRITE(UD,*) ERKOR IN WRITING XINF FILE'
                                                                                                                                                                                                                                                                                                                                                                                                            XINF(1, J) = (XINF(1, J) - STYP(J) / SVAR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               GC TO 770
TEMPMV(LJ)=BUFFER(J)
TEMPMV(JI)=BUFFER(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ITEMPMV(ITEMP+IJ)=I
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ITEMPNV(ITEMP+J1)=J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SDISTMX=0.
ITEMP=ISETHAM++2
DO 755 I=1,ITEMP
755 TEMPMV(I)=-1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              00 790 I=1 NP
II=IPINSET(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 770 J=1,NP
JJ=IPINSET(J)
                                                                                                                                                          UN DEN I=1, NV
                                                                                                                                                                                                  680 CONTINUE
690 DO 700 J=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IBUFFER(J)=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IBUFFER(1)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
BUFFER(I)=0
                                                                                                                                  8 AXES (V)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      REWIND 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            STOP 6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NVRHNV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       765
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802 CONTINUE
WRITE(06.*)' END POINTS FOR ABOVE DISTANCES (ONLY ONE FOR WITHIN
A SET)'
IF(IDIGIT(IOUTPC,IOMAXC).NE.G.AND.NP.GT.10JWRITE(06.+)' ROW',I IF(IDIGIT(IOUTPC,IOMAXC).NE.G; WRITE(06.70)(BUFFER(J),J=1,NP) WRITE(11,ERR=780)(BUFFER(J),J=1,NP) WRITE(11,ERR=780)(BUFFER(J),J=1,NP) WRITE(13,ERR=780)(IBUFFER(J),J=1,NP) GO TO 790 WHITE(UD,+)' ERROR IN WRITING EDIST,SUIST OR IDIST FILE' STOP 6
                                                                                                                                                                                                                                                                                                              IF(IDIGIT(IOUTPS,IOMAXS-9).EQ.G) GO TO 809
WRITE(06,*)' EUCLIDEAN DISTANCES BETWEEN SETS (ON DIAG>WITHIN, &OFF DIAG=BETWEEN)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 804 II=1, ISETNAM
WRITE(06,80)(ITEMPHOUTEMP+II+(JJ-1)*ISETNAM),JJ=1,ISETNAM)
BOA CONTINUE
WRITE(06,*)' POINT SET POINT SET DISTANCE'
DO BOB I=1,NP-1
II=IPINSET(1)
JI=(II-1)*ISETNAM
READ(!1)*(BOFFERK),K=1,NP)
DO 806 J=1+1,NP
DO 806 J=1+1,NP
HEBUFFIR(J) LEHPMV(JJ*J]*;1,OR.II.EQ.JJ) GO TO 806
WRITE(DD.80/J];11,J,JJ,BUFFER(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL VERTEX (XINF, NP, NV, NPMAX, N, MAX, IPINSET, ISETNAM, TEMPMV,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TO 972
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO BO2 II=1,ISETNAM
WRITE(06,70)(TEMPMV(II+(JJ-1)*ISETNAM),JJ=1,ISETNAM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 971 K=1,1SETNAM
IF(AXLENG(L+(K-1)+NV),GE.AXLENG(1+(K-1)+NV)+.05) GO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    972 CONTINUE
975 CALL VERTALATH, HP.L.NPMAA,NVMAA,NPINSET,ISETNAM,
8TEMPMV(1+2*NV),ITEMPMV(1+2*NV))
60 980 I=1.NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         809 DO 812 I=1.8*ISETNAM*NVMAX
812 ITEMFMV(I)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 806 CONTINUE
807 FORMAT(16,14,10,14,F7.3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IOUTSC=1UMAXC=1UMAXS=2
DO 960 I=1, ISETNAM
NPIN(1)=NPINSEI(1)
GO TO 7075
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NSETCL=1SETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IOUTPSC-10UTPS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      970 DO 972 L-1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CHSETCL = CHSET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          REWIND 13
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     GO TO 975
                                                                                                                                                                                                                     REWIND 11
                                                                                                                                                                                                                                         REWIND 12
                                                                                                                                                                                                                                                                 REWIND 13
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      & I TEMPMV )
                                                                                                                                                                                           79U CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             808 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             971 CUNTINUE
                                                                                                                                               .
□ D /
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WRITE(06,*)''
WRITE(06,*)''(ENGTH OF THE ALLDATA SEMIAXES'
WRITE(06,70)(AXLTOT(I),I=1,NAXTOT)
) IF(IDIGIT(IOUTPUT,IOMAX-4),EQ.0) GO TO 905
WRITE(06,*)''
WRITE(06,*)'
WRITE(06,*)'
A A E S (U)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(06.*)'
WRITE(06.*)' DATA TRANSFORM FROM ALLDATA AXES (V) TO ORIGINAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE(06,100)CHV,1,TEMP,((CHS(J),ABS(AXTOT(1,J)),CHU,J),J=1,
&MINO(3,NV))
IF(NV.GI.3)WRITE(06,110)((CHS(J),ABS(AXTOT(I,J)),CHU,J),
                                                                                                                                                                                   WRITE(06,*)
WRITE(06,*)' CENTER OF GRAVITY OF ALLDATA
WRITE(06,70)(CGTOT(J),J=1,NV)
WRITE(06,*)'
WRITE(06,*)'
WRITE(06,*)'
WRITE(06,*)'
WRITE(06,*)'
                                                                                WRITE(06, .) STUP. IO ERROR IN READING XINF FILE
                                                                                                                                                                                                                                                                800 XINF(I,J)=XINF(I,J)-CGTOT(J)
810 AXLTOT(J)=0.
CALL BOTTLE(XI,F(I,I),AXES(I,I),AXLTOT(I),NV,NP)
DO 820 I=1,NV
IF(AXLTOT(I).NE.O.)NAXTOT=I
                                                                                                                                                                                                                                                                                                                                                                                                                                830 AXTOT(1,J)=AXES(1,J)
IF(IDIGIT(IOUTPUT,IOMAX-3).EQ.0) GO TO 850
READ(10, END=985, ERR=985) (XINF(1,J), J=1,NV)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE(UE, 70) (AXTOT(I, J) *AXLTOT(I), J=1,NV)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     & AXES (J)'
DO 900 J=1,NV
DO 890 II=1,NAXTOT
IF(AXTOT(II,J),GE.O.)CHS(II)=CHP
A=CHM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(AXTOT(1,J).GE.U.)CHS(J)=CHP
IF(AXTOT(1,J).LT.O.)CHS(J)=CHM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        TEMP=TEMP-AXTUT(1, J) *CGTOT(J)
DO 870 J=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 840 I-1, NAXTOT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 880 1-1, NAVIOL
                                                                                                                                                                                                                             DO 810 J-1, NV
                                                                                                                                                                                                                                              DO 800 I=1,NP
                                                                                                                                                                                                                                                                                                                                                                                              DO 830 I=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                   DO 830 J=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 860 J-1,NV
                                                                                                                                           990 AXLTOT(1)=0.
                                                                                                                                                              CGTOT(1)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               & IN ROWS)'
                                                               GO TO 930
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              870 CONTINUE
                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                         820 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   880 CONTINUE
                      980
                                                                                  985
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                つてわ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 850
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            960
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1F(NAXTOT.GT.3)WRITE(06,110)((CHS(II),ABS(AXTOT(II,J)),CHV,II),
&II=4,NAXTOT)
                                                                                               900 CONTINUE
905 IF(IDIGIT(IOUTPUT,IOMAX-5).EQ.0) GO TO 2085
WRITE(00,*)' ' WRITE(00,*)' TRANSFORMED DATA POINTS, WITH POINT,SET NUMBER AT
                                                                                                                                                                                                                                                                                      IF(AXLENG(L+(K-1)*NV).LT.AXLENG(1+(K-1)*NV)*.05) GO TO 2020
             WRITE(U6,100)CHU,J,CGTOT(J).((CHS(I1),ABS(AXTOT(I1,J)),CHV,
&I1),I1-1,MINO(J,NAXTOT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF(IDIGIT(10U1PS,10MAXS),EQ.0) GO TO 2080
WRITE(06,2U/6)F.JJ.NPINSET(K)
WRITE(06,GO)(ITEMPMV(JJJ+KK),JJJ=1,JJ)
FURMAT(' SET NUMBER',I4', (',15', OF',15', POINTS)')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (ITEMPMV(J+KK).EQ.ITEMPMV(J-1+KK)) GO TO 2060
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ITEMP0=ITEMP0+1
DO 2022 J=J0.2*NV
IF(ITEMP0-ITEMPMV(J+KK+2*NV)) 2023,2021,2022
                                                                                                                                                                                                                                                                                                                                                                  WRITE(06.*) ' KNOWN VERTEX POINTS OF EACH SET
                                                                                                                                                                                                                       WRITE(06,75)1, IPINSET(I), (XINF(I,J), J=1,NV)
                                                                                                                                                                                                                                                                                                                            NVINSET(I)=NPINSET(I)
IF(IDIGIT(IOUTPS,IOMAXS).EQ.0) GO TO 931
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL SORT(ITEMPMV(1+KK+2+NV), 2*NV, 1, 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF(IABS(IPINSET(I)).NE.K) 60 TO 2025
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF(ITEMPMV(J+KK).NE.0) GO TO 2040
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL SORT (ITEMPMV(1+KK), 4*NV. 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 2050 JJ=1,J
ITEMPMV(JJ+KK)=ITEMPMV(J+KK)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |TEMPMV(JJ+KK)=|TEMPMV(J+KK)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          2085 IF(ISETNAM.LE.1) GO TO 6000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(JJ.Eq.0) GO TO 2075
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ITEMPMV(J+KK+2*NV)=I
                                                                                                                                                                                                                                                                                                         930 DO 2000 I=1, I SETMAX
                                                                                                                                                                                                                                                                                                                                                                                                                               DO 2080 K=1.1SETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 2070 JJJ=JJ+1,J
ITEMPMV(JJJ+KK)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 2030 J=1,4*NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                    KK=(K-1) *4*NVMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 2060 J=2,4*NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 2010 L=1,NV
                                                                                                                                                                                                                                                                 GO TO 2085
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               2010 CONTINUE
2020 CALL SORT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                            910 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                            ITEMP0=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
890 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             2030
2040
2050
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            2070
2075
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          2076
2080
                                                                                                                                                                                                                                                                                                                              2000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          2023
2025
2029
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               2060
                                                                                                                                                                                                                                                                                                                                                                                                             931
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                2021
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L8=L7+Nv1
IF(IDIGIT(IOUTPS,IOMAXS).NE.O)WRITE(06,*)' REDUNDANT POINTS AS IF(IDIGIT(IOUTPS,IOMAXS).NE.O)WRITE(06,*)' REDUNDANT POINTS AS DO 2240 K=1,ISETNAM KK=(K-1)*4*NVMAX DO 2090 I=1,4*NVMAX IF(ITEMPMV(I+KK).EQ.O) GO 10 2100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL NOSMPLX(TEMPMV(1+L2),NV1,NV1,KVERTEX,ITEMPMV(1+L3),
BITEMPMV(1+L4),ITEMPMV(1+L5),ITEMPMV(1+L6),IRANK,TEMPMV(1+L7)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 2110 1=1,NV
2110 TEMPMV(I+(J-1)*NV1+L2)=XINF(ITEMPMV(J+(K-1)*4*NVMAX),1,
CALL LUFACTR(TEMPMV(1+L2),NV1,NV1,KVERTEX,ITEMPMV(1+L3),
&ITEMPMV(1+L4),ITEMPMV(1+L5),ITEMPMV(1+L6),IRANK)
CALL BACKS(TEMPMV(1+L2),NV1,NV1,KVERTEX,ITEMPMV(1+L3),
&ITEMPMV(1+L4),ITEMPMV(1+L5),ITEMPMV(1+L6),IRANK)
DO 2120 I=1,NV1*(4*NV1+7)
2120 TEMPMV(L1+1)=TEMPMV(L2+1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 2160 J=1,NV
2160 TEMPMV(J+LS)=TEMPMV(J+LS)+XINF(IS,J)*TEMPMV(I3+L7)
2170 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                TO 2240
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(TEMPWV(13+L7).LE.0.) GG TO 217G
TEMPO=TEMPO+TEMPWV(13+L7)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 223U I=1, KVERTEX+1
I2=ITEMPMV(I+(K-1)*4*NVMAX)-1
IF(I.GT.KVERTEX) I2=NP
IF(I.GT.KVERTEX) I2=NP
IF(II.GT.IZ) GO TO 2220
DO 2210 II=I1, I2
IF(IPINSET(II).NE.K) GO TO 2210
DO 2130 J=1,NV
Z130 TEMPMV(J+L7)=X.NF(II,J)
TEMPMV(NV1+L7)=1.
                                                                                                                                                                                                                                                                                                                                                                                                           IF(KVERTEX.EQ.NPINSET(K)) GO
DO 2110 J=1,KVERTEX
TEMPMV(NVI+(J-1)+NVI+L2)=1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 2140 J=1,NV1*(4*NV1+7)
2140 TEMPMV(L2+J)=TEMPMV(L1+J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF(IFEAS.EQ.0) GO TO 2190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     15=ITEMPMV(14+(h-1)+
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 2170 III=1, IRANK
L2=L1+4+NV1+(2+NV1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                I3=ITEMPMV(III+L3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           I4=ITEMPMV(III+L4)
                       L3=L2+4*NV1*NV1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 2150 J=1,NV
TEMPMV(J+L5)=0
                                                                                                                           L7=L6+4*NV1
                                                                                                                                                                                                                                                                                                                                                                                      2100 KVERTEX=I-1
                                                    L4=L3+NV1
                                                                            L5=L4+NV1
                                                                                                 L6=L5+NV1
                                                                                                                                                                                                                                                                                                                                   2090 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               EMP0=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       TEMP2=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     & IFEAS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TEMP1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              2150
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P(NVP3.1) + . IF ITH PAIR OF SETS IS DISJOINT OVERLAPS IF(IDIGIT(100175, 10MAXS-2).NE.0) WRITE(06,*)' DISJOINTNESS OF & CONVEX HULLS OF PAIRS OF SETS, IN SPACE OF ALLDATA AXES'
                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE(06,2207)(CHS(II), ABS(TEMPMV(ITEMPMV(III+L3)+L7)),
BITEMPMV(ITEMPMV(III+L4)+(K-1)+4+NVMAX),III=4*I1,MINO(4*II+3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             2260 IF(IDIGIT(10UTPS, 10MAXS-2).EQ.0.AND.IDIGIT(10UTPS, 10MAXS-3) & 26Q.0.AND.IDIGIT(10UTPS, 10MAXS-10).EQ.0) GO TO 4000
                                                                                                                                                                                                                                                                                                                 WRITE(06,2200)11, (CHS(111), ABS(TEMPMV(ITEMPMV(III+L3)+L7)), &ITEMPMV(ITEMPWV(III+L3)+(K-1)*4*NVMAX), III=1, MINO(3, IRANK)) 22CO FORMAT('P', 14, '=', 9X, 3(3X, A1, F9.4, 'P', 14))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           REDUNDANT POINTS OUT OF', NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SET TO WHICH POINT BELONGS (-MEANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL INSECT(XINF, IPINSET, II, JJ, IL, NP, TEMPMV, ITEMPMV, IER)
                                                                                                                                     NVINSET(IABS(IPINSET(II)))=NvINSET(IABS(IPINSET(II)))=1
IF(IDIGIT(IDUTPS,IDMAXS).Eq.u. do TO 2210
DO 2195 III=1,IRANK
CHS(III)=CHP
IF(TEMPMV(ITEMPMV(III+L3)+L7).LT.0.)CHS(III)=CHM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       #RITE(06,60)(IPINSET(J),J=IPRINT,MINO(NP,IPRINT+9))
DO 2180 J=1,NV
TEMP1=TEMP1+(TEMPN/J+LS,/TEMPO-XINF(II,J))**2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         2246 IF(IDIGIT(IOUTPS, IOMAXS-1).EQ.0) GO TO 2260
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(IDIGIT(IOUTPS, IOMAXS), EQ. 0) GO TO 2246
                                                  2180 TEMP2=TEMP2+XINF(II, J)++2
1F(TEMP1,GT,TEMP2+10,E-8) u0 T0 2210
2190 IPINSET(II)=-IPINSET(II)
                                                                                                                                                                                                                                                                                                                                                                                                                                 2205 IF(4*11-1.GE.IRANK) GO TO 2210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(Oc. . ) FOUND ITEMPO,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     2207 FORMAT(4(2X, A1, F9.4, ' P', 14))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           2245 ITEMPO=ITEMPO-NVINSET(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE(06,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               56 2250 I=1,(NP+9)/10
IPRINT=1+(I-1)*10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL UERSEI(1ER, 1ER1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 2340 I=1, ISETNAM-1
DO 2340 J=1+1, ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 2245 1=1,1SETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 & REDUNDANT PUINT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         33 2270 L-1, NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            P(NVP3.K)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        I TEMPO=NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        2210 CONTINUE
2220 I1=I2+2
2230 CONTINUE
2240 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      & FOINTS
                                                                                                                                                                                                                                                                                      2195 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       2250 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  11=11+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          &IRANK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IER1=4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        1 ER=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      1 = 1 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              C SET
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WRITE(06,2320)(CHS(I1),ABS(TEMPMV(N1+I1)),ITEMPMV(N2+I1),I1=1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   L=ABS(1.UU)+P(NVP3.K))
CALL DISCRM (XINF, IPINSET, II, JJ, L, NP, NVINSET(II)+NVINSET(JJ)
&, P(2,K), P(1,K), P(NVP3-1,K), SOS, IER)
IF(IER.NE.O) WRITE(O6.*) DISCRIM IER = . IER . FOR SETS'. I, J
IF(IER.LT.70.A.º) P(NVP3.K).LT.O..AND.ITEMPO.EQ.I.AND.L.LT.NV)
                                                                                                               1F(!DIGIT(!OUTPS,!OMAXS-2).EQ.0) GU TO 2340
WRITE(06,2280)!!.JJ.CHNOT.IL
2280 FORMAT(' SETS'.14.14'',A3,' DISJOINT IN SPACE OF FIRST'.14
&, AXES')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             2370 IF(IDIGIT(IOUTPS, IOMAXS-3). EQ. 0. AND. IDIGIT(IOUTPS, IOMAXS-10)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          GO TO 2325
2330 IF(IDIGIT(IOUTPS,IOMAXS-2).NE.0) WRITE(06,2280)II,JJ,CHBL,IL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  2400 WRITE(06,*)' ' WYPERPLANES FOR SET DISCRIMINATION, IN TERMS OF
                                                         9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE(U6,2327)(CHS(I2),ABS(TEMPWV(N1+12)),ITEMPMV(N2+12),

BI2=4*I1+1,MINO(4*(I1+1),ITEMPMV(N2)))

2327 FORMAT(3X,4(A1,F9.4, 'P',I4))
                        WRITE(06,2274)II, JJ, IL
2274 FORMAT('SET', 14, 14, 'DISJOINTNESS UNDECIDED IN SPACE
& FIRST, 14, AXES')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                REWIND 22
GO TO 2400
2390 WRITE(06,*)' ERROR IN WRITING XINF FILE
                                                                                                                                                                                                                                         WRITE(06,*)' AN INTERSECTION IS:'NI=2*(NVINSET(II)+NVINSET(JJ))+2*IL+7
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           2325 IF(4*I1-1.GE.ITEMPMV(N2)) GO TO 2340
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE(22, ERR=2390)(XINF(I,J), J=1,NV)
                                                                                                                                                                                                                                                                                                                                                                            IF(TEMPMV(N1+I1), LT.0.) CHS(I1)=CHM
                                                                                                                                                                                                                                                                                                                                                                                                                                                       &MINO(4_ITEMPMV(N2)))
2320 FORMAT(' 0=',4(A1,F9.4,' P',I4))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF(P(NVP3,K),GT.0.) SOS= 1.
IF(IER.NE.132) GO TO 2275
                                                                                                                                                                                                                                                                                             NZ=N1+IL+3
DO 2310 I1=1,ITEMPMV(N2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           & TRANSFORMED VARIABLES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DU 2440 1=1,1SETNAM-1
DU 2440 J=1+1,1SETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        &EU.0) GO TO 4000
DO 2380 I=1,NP
                                                                                                          2275 P(NVP3.K)=-IL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                P(NVP3,K)=+IL
                                                                                                                                                                                                                                                                                                                                                 CHS(II)=CHP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        2506 ITEMP0=0
2402 SOS=+1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           2340 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TEMP1-1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                STOP 8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  K=K+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 1 = 1 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         -----
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IF(IER.EQ.133) GO TO 2330

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GO TO 2402
2405 WRITE(06.*): NEITHER OVEKLAP NOR SEPARATION CASE SOLVABLE FOR
                                                                                                                                                                                                                                                                                                                                                                                   WRITE(06,2430)((CHS(J!),ABS(P(J!,K)),CHV,J!-!),
& J!=2,MINO(4,L+!))
IF(L+!.GT.4)WRITE(06,110)((CHS(J!),ABS(P(J!,K)),CHV,J!),J!=5,
                                                                                                                                                    DISTANCE(RHS) TO POINT, NORMAL TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SEPARATION BETWEEN SETS', 13, '8', 13, ' = ', E11.4)
OVERLAP OF SETS', 13, '8', 13, ' = ', E11.4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                     2430 FORMAI( RHS IS '.A2.E10.3,'*',A1,'(',12,')',A2
8E10.3,'*',A1,'(',12,')',A2.E10.3,'*',A1,'(',12,')')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF(P(NVP3.K).GE.0) WRITE(06,2446)I,J,P(1,K)-P(NVP3-1,K) IF(P(NVP3.K).LT.0) WRITE(06,2447)I,J,P(NVP3-1,K)-P(1,K)
          IF(IER.LT.70) GO TO 2408
IF(ITEMPO.NE.U) GO TO 2405
WRITE(06.2403)I.J
2403 FORMAT('TRVING OPPOSITE CASE AS
& HYPERPLANES NOT SOLVABLE FOR SETS'.I3'''I3)
P(NVP3.K)=-P(NVP3.K)
                                                                                                                                                                                                                                                                                                                                 IF(P(11,K).GE.U) CHS(11)=CHP
IF(P(11,K).LT.U) CHS(11)=CHM
2420 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 2445 I=1, ISETNAM-1
DO 2445 J=1+1, ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TOLRED=.2

DO 2455 I= ,NSPAIR

HCONL(I)=V3IGNO

HCONR(I)=-V8IGNO

TEMPV(2*NSPAIR+I)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE(06,*)
8 GO 10 2509
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 2445 CONTINUE
2446 FORMAT(' 5
2447 FORMAT(' C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TOI H= 16-5
                                                                                                            I TEMPO = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      244U CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       М:
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IF(P(NVP3,K1),LT.0.,AND.J1.EQ.ID.AND.TEMP1.GT.P(1,K1))ITEMP=1
IF(CHEB(K1),EQ.CHB) TEMPV(2*NSPAIR+K1)=TEMPV(2*NSPAIR+K1)+1.
IF(CHEB(K1),EQ.CHE) TEMPV(NSPAIR+K1)=TEMPV(NSPAIR+K1)+1.
IF(I1.EQ.ID.AND.I.GT.1) HCONL(K1)=AMIN1(HCONL(K1,TEMPV(K1))
IF(J1.EQ.ID.AND.I.GT.1) HCONR(K1)=AMAX1(HCONR(K1,TEMPV(K1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(06,2480)I, ISETID(ID), IPINSET(I), (TEMPV(K2), CHEB(K2), & K2=1.MINO(ITEMPO,8))

IF(ITEMPO,GT.8)wRITE(06,2490)(TEMPV(K2),CHEB(K2),K2=9,ITEMPO)
2480 FORMAT(I4,12,12,8(F7,4,41))
2490 FORMAT(50( ,8(F7,4,41),1))
2500 CONTINUE
REWIND 22
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(I1.EQ.ID) TEMP1=TEMPV(K1)-TOLRED
IF(J1.EQ.ID) TEMP1=TEMPV(K1)+TOLRED
IF(P(NVP3,K1).GE.0.AND.I1.EQ.ID.AND.TEMP1.LT.P(1,K1)) ITEMP=1
IF(P(NVP3,K1).LT.0.AND.I1.EQ.ID.AND.TEMP1.LT.P(NVP3-1,K1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(ITEMP.EG.O) IPINSET(I)=-IABS(IPINSET(I))
DQ 2475 K2=1,ITEMP0
IF(ABS(TEMPv(K2)).GT.9.9999) TEMPV(K2)=SIGN(9.9999,TEMPV(K2))
                                                                                                                                                                                                                                                                                                                                                                             IF(I1.NE.ID.AND.J1.NE.ID) GO TO 2470
IF(I1.EQ.ID.AND.TEMPV(K1)-P(1,K1).LT.-TOLH)CHEB(K1)=CHE
IF(J1.EQ.ID.AND.TEMPV(K1)-P(NVP3-1,K1).GT.+TOLH)CHEB(K1)=CHE
IF(TEMPV(K1)-P(1,K1).GE.-TOLH.AND.TEMPV(K1)-P(NVP3-1,K1).LE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE(06,*)'
WRITE(06,2503)(TEMPv(NSPAIR+K2),K2=1,MINU(ITEMPU,B))
IF(ITEMPO,GI.B) WRITE(06,2504)(TEMPV(NSPAIR+K2),K2=9,ITEMPO)
FORMAT(' E TOTALS',F6.0,7(F8.0))
FORMAT(' E TOTALS',F6.0,7(F8.0))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE(06,*)? NO E'S OCCURRED. (NO VIOLATION OF HYPERPLANES) GO TO 2507
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF(P(NVP3,K1).GE.O..AND.J1.EQ.ID.AND.JEMP1.GT.P(NVP3-1,K1))
                                                                                                                                                                                                                                                                  L=ABS(1,001*P(NVP3,K1))
D0 2460 L1=1,L
TEMPV(K1)=TEMPV(K1)*BUFFER(L1)*P(L1+1,K1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          2512
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 2501 I=1,NSPA1k
IF(TEMPV(NSPA1R+I).NE.0.) GO TO 2502
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WKITE(06.*)''
DO 2511 I=1,NSPAIR
IF(TEMPV(2*NSPAIR+1).NE.O.) GO
TEMPV(NSPAIR+1)=(),

DO 2500 [=1,N]

READ(22)(GUFFER(J)),JI=1,NV)

ID=IABS(IFINSET(I))
                                                                                                                                                           DO 2470 1:=1,ISETNAM=1
DO 2470 0:=[1+1,ISETNAM
K1=K1+1
TEMPV(K1)=0
                                                                                                                                                                                                                                                                                                                                                    CHEB(K1)=CHBL1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE(06,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SCHEB(K1)=CHB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   2503 FORMAT( E
2504 FORMAT(50)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   2511 CONTINUE
                                                                                                                                    ITEMP=0
     2455
                                                                                                                                                                                                                                                                                                                              2460
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               2501
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        2502
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 2507
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            2470
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     2475
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3*FITE(06,*)NSETOUTT,(ISETOUTT(I),I=1,MINO(NSETOUTT,ISETMAX))
*FITE(06,*)' ENTER N(LE 20) THEN NAME N POPULATION POINTS TO BE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              *RITE(06,*)' NAME REVISED SAMPLE & POPULATION FILES (IN SAMPLE & FÖRMAT)('' '' IF NONE)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF(KZ.EQ.O) GO TO 2515
WRITE(06.2516) II.JI.P(I.KI).P(NVP3-1,KI).HCONL(KI).HCONR(KI)
FORMAT(16.17.' '4E11.4)
                        GO TO 2517
2512 #RITE(06,2513)(TEMPV(2*NSPAIR+K2),K2=1,MINO(ITEMPO,8))
IF(ITEMPU.GT.8)WRITE(06,2504)(TEMPV(2*NSPAIR+K2),K2=9,ITEMPO)
25:3 FORMAT(' B TOTALS',F6.0,7(F8.0))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE(06,*): NO B"S OCCURRED. (NO PTS IN HYPERPLANE OVERLAP)?
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ(05,*)NSETOUTT.(ISETOUTT(I),1=1,MINO(NSETOUTT,ISETMAX))
IF(IMODE.EQ.U)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     3059 FORMAT(' ENTER N(LE', 14, ')THEN ID OF N SETS TO BE EXCLUDED & (-1 FOR ALL NEW SETS)')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WHICH POINT BELONGS (-MEANS
                                                                                                                                                                                                                                                                                                                    WRITE(06,2490)(HCONR(KZ), CHBL1,KZ=1,ITEMPO)
WRITE(06,*)' IMPROVEMENTS TO HYPERPLANE LEFT HAND SIDES'
WRITE(06,*)' + EFTNO. RIGHTNO. LEFTOLD RIGHTOLD LEF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      &HCONR(KI),LT.HCONL(KI)) K2=1
IF(P(NVP3,KI),LT.O.AND.P(1,KI),LT.P(NVP3-1,KI),AND.
&HCONL(KI),GT.P(1,KI)-TOLH,AND.HCONR(KI),LT.P(NVP3-1,KI)
                                                                                                                                                                                                                      #RITE(06.+) MINIMUM OF HYPERPLANE RHS FOR LEFT SETS' #RITE(06.2490)(HCONL(K2), CHBL1,K2=1,ITEMPO) #RITE(06.+) MAXIMUM OF HYPERPLANE RHS FOR RIGHT SETS'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ(05,*)FILINR.FILINT
iF(IMODE.EQ.0)WRITE(06,*)FILINR.FILINT
iF(FILINR.EQ.FILECR.AND.FILINT.EQ.FILECR) GO TO 4000
iF(FILINT.EQ.FILECR) GO TO 3049
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           *EAD(US.*)NPIUUII.(IPIUUIII),I=1.MINU(NPIUUII.ZU))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE(06,60)(IPINSET(J), J=IPKINT, MINU(NP, IPRINT+9))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (P(NVP3,K1), GE.O. AND. P(NVP3-1,K1), LT. P(1,K1), AND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              3000 IF(IDIGIT(IOUTPS, IOMAXS-10). EQ. 0) GO TO 4000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        2520 if(IDIGIT(IOUTPS, IOMAXS-1).EQ.0) GO TO 3000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 2515 11=1, ISETNAM-1
DO 2515 J1=11+1, ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            P(1,K1)=HCON(K1)
P(NVP3-1,K1)=HCONR(K1)
2515 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            JO 2510 I=1, (NP+9)/10 IPRINT=1+(I-1)*10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE(06,3059) | SETMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DC 3051 1=1, ISETMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                & REDUNDANT POINT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  3051 ISETOUTT(I)=0
                                                                                                                                                                                       2517 MRITE(06,+)
                                                                                                                                                                                                                                                                                                                                                                                                                         RIGHTNEW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              251C CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            2516
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WRITE(06,+) ERHUR UPENING REVISED SAMPLE FILE. ISTAT=', ISTAT
                                                                                                                                                                                                                                IF (IMODE.EO.1) THEN
WRITE(06.*) ' REVISED SAMPLE FILE', FILINR, ' ALREADY EXISTS.
WRITE(06.*) ' ENTER 1 TO OVERWRITE OR 2 TO ENTER NEW NAME.'
                                                                                                                                           3054 WRITE(06,+)' ENTER N,THEN N PAIRS OF 1DS TO BE LABELED AS THE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ(05,*)NSETCOT, (ISETCOT(I), I=1,2*MINU(NSETCOT,ISETMAX))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     PLEASE TRY AGAIN.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE(06,*)' NAME REVISED SAMPLE FILE ('' ' IF NONE)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(IMODE.EQ.0)WRITE(OG.*)FILINR
3062 IF(FILINR.EQ.FILECR.AND.FILINT.EQ.FILECR) GO TO 4000
IF(IMODE.EQ.0)
&WRITE(06.*)NPTOUTT,(IPTOUTT(I),I=1,MING(NPTOUTT,20))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      (IOVERW.EQ.1) THEN
OPEN(03,FILE=FILLINR.STATUS='OLD'.IOSTAT=ISTAT,
ACCESS='SEQUENTIAL',FORM='FORMATTED')
                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(06,*) . NAMING REVISED SAMPLE FILE , FILINR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (.NOT.EXIS) THEN
OPEN(03.FILE=FILINR.STATUS='NEW', IOSTAT=ISTAT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IOVERW.NE.2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ACCESS='SEQUENTIAL', FORM='FORMATTED')
IF (ISTAT NE.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE(FILINR, 3063) (TIMEOUT-TIMEIN) +3600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   " MUST ENTER 1 OR 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 3053 I=1,NSETOUTT
IF(ISETOUTT(1),EQ.-1) GC TC 3052
                                                  IF(NSETOUTT.EQ.0) GO TO 3054
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ(05,*) IOVERW
IF (IOVERW.NE.1
WRITE(06,*) MU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ(05, +) FILINR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          (EXIS) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                          FORMAT (FB.2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              GO TO 3062
                                                                                                                            GO TO 3054
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          END IF
                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                          3063
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                3061
                                                                                                           3053
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             3050
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.AND. FILINT.EQ.FILECR) GO TO 4000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(NSETOUT.EQ.0. AND NPTOUT.EQ.0. AND.NSETCOM.EQ.0) GO TO 3079
IF(NSETOUT.LE.0) GO TO 3073
DO 3072 K=1, NSETOUT
IF(ITEMP.EQ.1SETOUT(*)) GO TO 3071
E(Ub.* ERROR OPENING REVISED SAMPLE FILE...
                                                                                                                                                                                                                                                                                                                                                      WRITE(06,*) · NAMING REVISED SAMPLE FILE · FILINR OPEN(03,FILE=FILINR.SIATUS='NEW', IOSTAT=ISTAT, ACCESS='SEQUE**TIAL', FORM="FORMATTED")
IF (ISTAT.NE.G) THEN
WRITE(06,*) = ERROR OPENING REVISED SAMPLE FILE.', ISTAT=':STAT
                                                                                                                                                                                                                                                                                               CALL PTIME(TIMEGUT)
WRITE(FILINR,3653)INT((TIMEOUT-TIMEIN)+3600,+1000.)
                                                                                                               IF (10VERW.EQ.2) THEN
WRITE(00.+) ENTER NAME OF REVISED SAMPLE FILE:
(''' IF NONE)'
READ(05.+) FILINR
IF (FILINR.EC.FILECR AND, FILINT.EQ.FILECR) GG GO TO 3049
END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     3070 I=I+1
3071 READ(01,90,END=3075):BUFFER(L),L=1,INMAX)
NPTEMP=NPTEMP+1
NPTEMP=NPTEMP+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF(FILINR.EQ.FILECR. GO TO 3080 DO 3058 I-1, ISETMA? NPINSETT(I)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     C***** SECTION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL ATFILE(FILIN(1), NFILE)
 IF (ISTAT. Ne. J.) THEN WRITE(US. * ERROR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF(NPTOUT.LE.0) GO TC 3076
DO 3074 N=1,NPTOUT
                                                                                                                                                                                                                                                                             IF (IMODE.EQ.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 3069 J=1,6*ISETMAA
ITEMPMV(K3+I)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL FMEDIA(03.6)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            K3=NSPAIR*NVNLMAX
                                                                                                                                                                                                                                                                                                                                     FORMAT(18)
                                                            STOP
                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          STOP
END IF
                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ITEMP2=U
ITEMP3=0
ITEMP4=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END 1F
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 3064 ITEMP1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ITEMP5=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 I TEMP6=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TEMP7=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    3072 CONTINUE
3073 IF(NPTOU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ITEMP8=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  6908
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            305B
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IF(NSETOUTT, EQ. 0, AND, NPTOUTT, EQ. 0, AND, NSETCOT, EQ. 0) GO TO 3235 IF(NSETOUTT, LE. 0) GO TO 3225 DO 3224 K=1, NSETGUTT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               SAMPLE PLANES APPLIED TO TRANSFORMED POP FILES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      b, LESS NEW EXCLUSIONS'
WRITE(06,*)' POINT SET DISTANCE(RHS) TO POINT, NORMAL 10
b PLANES (E=ERROR,B=BAND)'
IO=(ISETNAM*(ISETNAM=1))/2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               OPEN(UZ,FILE=FILINT,STATUS='OLD',IOSTAT=ISTAT,

&ACCESS='SEQUENTIAL',FORM='FORMATTED')

IF (151AT.NE.O) THEN

WRITE(06.*) 'ERROR OPENING FILINT FILE. ISTAT=',ISTAT
                                                                                                                                                                                                                                            3080 WRITE(06,*)' ERRUR IN TRANSCRIBING PT', I, ' FROM SAMPLE TO
& REVISED SAMPLE DATA BASE, PROCEEDING.'
                                                               DO 3077 k=1,NSETCOM
IF(ITEMP.EQ.ISETCOM(2*K)) BUFFER(ISETVAR)=ISETCOM(2*K-1)
                                                                                                                                                                          NPINSETT(!ABS(!PINSET(!)))=NPINSETT(!ABS(!PINSET(!)))+1
WRITE(U3,90,ERR=3060)(BUFFER(L),L=1,INMAX)
GO TO 3070
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
IF(IPINSET(I).LT.0.AND.I.LE.NPMAX) GO TO 3070
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ(02, 90, END=3495) (BUFFER(L), L=1, INMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF(NPTEMP.EQ.IPTOUTT(K)) GO TO 3220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TO 3220
IF (NPTEMP. EQ. IPTOUT (K)) GO TO 3071
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF(INEW.EQ.0) GO TO 3225
DO 3221 K=1,1SETNAM
IF(ITEMP.EQ.1SETID(K)) GO TO 3225
                                                                                                                                                                                                                                                                                                                                                                                                                               IF(FILINT.EQ.FILECR) GO TO 3499
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(NSETCOT.EQ.0) 50 TO 3239
DO 3233 K=1,NSETCOT
                                          IF(NSETCOM.LE.0) GO TO 3079
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF(ITEMP.EQ.I. FTOUT(K)) GO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF(NPTOUT, LE. 0) GO TO 3235
DO 3230 K=1, NPTOUTT
                                                                                                                                                                                                                                                                                                             3075 NFILE=NFILE+1
CALL ATFILE(FILIN,NFILE)
IF(NFILE,NE.0) GO TO 3070
3G80 ISETNAMP=ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 3085 I=1,NSPAIR
TEMPV(NSPAIR+NVMAX+I)=0.
NPTEMP=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ITEMP-BUFFER(ISETVAR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE(06,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                     3074 CONTINUE
                                        3076
                                                                                                         3077
3079
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       3085
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3235
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             3221
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IF(TEMPV(K1). LE.P(1,K1). AND. TEMPV(K1). GE.P(NVP3-1,K1))CHEB(K1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF(TEMPV(K1).GE.P(1,K1).AND.TEMPV(K1).LE.P(NVP3-1,K1))CHEB(K1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(CHCF.EQ.CHE)TEMPV(NSPAIR+NVMAX+ID)=TEMPV(NSPAIR+NVMAX+ID)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 3260 WRITE(06,*)' ERROR IN WRITING POPULATION PT' NPTEMP, 'ONTO
& REVISED SAMPLE DATA BASE. PROCEEDING.'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF(II.NE.ID.AND.JI.NE.ID) GO TO 3465
IF(II.EQ.ID.AND.TEMPV(KI)-P(I,KI).LT.-TOLH)CHCF=CHE
IF(JI.EQ.ID.AND.TEMPV(KI)-P(I,KI).LT.-TOLH)CHCF=CHE
IF(JI.EQ.ID.TEMP)=TEMPV(KI)-TOLKED
IF(JI.EQ.ID) TEMP)=TEMPV(KI)-TOLKED
IF(JI.EQ.ID) TEMP)=TEMPV(KI)-TOLKED
IF(JI.EQ.ID) TEMP)=TEMPV(KI)-TOLKED
IF(II.EQ.ID) TEMP)=TEMPV(KI)-TOLKED
IF(TEMP)=TEMP)=TEMP)=TEMP(KI)=TEMP)
IF(TEMPV(KI).TT.TEMP)=CHEB(KI)=CHGT
IF(TEMPV(KI).LT.TEMP)=CHEB(KI)=CHLT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 3300 TEMPV(J)=(BUFFER(IN(J))-STYP(J))/SVAR(J)-CGTOT(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              L=ABS(1,001*P(NvP3,K1))
DO 3460 L1=1,L
TEMPV(K1)=TEMPV(K1)+P(L1+1,K1)*TEMPV(L1+12)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                00 3320 J=1,NV
3320 TEMPV(I+I2)=TEMPV(I+I2)+AXTOT(I,J)*TEMPV(J)
                                                                                                                                                                                                                                                                                                                                                                                    | ITEMP3=|TEMP3+|
WRITE(03,90,ERR=32&0)(BUFFER(L),L=1,INMAX)
GO TO 3251
                                                   IF(ISETVAR.GT.0)|PINST=ITEMP
DO 3240 ID=1,ISETVAM
IF(IPINST.EQ.ISETID(ID)) GO TO 3250
                                                                                                                                                              IF(ISETNAMP.EQ.0) GU TO 3245
DO 3244 ID=ISETNAM+1, ISETNAMP
IF(IPINST.EQ.1SETID(ID)) GO TO 3247
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF(CHCF.NE.CHE) GO TO 3489
IF(ID.GT.ISETNAM) GO TO 3489
                                                                                                                                                                                                                                                                                                                                                           3247 NPINSETT(ID)=NPINSETT(ID)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 3470 11=1, ISETNAM-1
DO 3470 J1=11+1, ISETNAM
K1=K1+1
TEMPV(K1)=0.
                                                                                                                                                                                                                                                                                                        ISETID(1SETNAMP)=IPINST
                                                                                                                                                                                                                                                  3244 CONTINUE
3245 ISETNAMP=ISETNAMP+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    3478 LET, ISTHAM
                            3239 IPINST=ISETID(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 3320 I=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CHEB(K1)=CHBL1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        3251 DO 3300 J=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TEMPV(I+I2)=0.
                                                                                                                                                                                                                                                                                                                                    ID=ISETNAMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ITEMPV(L)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CHCF=CHBL 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            3250 NPT=NPT+1
                                                                                                                                    CONTINUE
3233 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               8 = CHEQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     & =CHNO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    3
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1F(ITEMP.EQ.ISETCOT(2+K))ITEMP=ISETCOT(2+K-1)

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DO 3492 N2-1,10
IF(ABS(TEMPV(K2)),GT.9.9999) TEMPV(K2)-SIGN(9.9999,TEMPV(K2))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     GO TO 3490
3460 WRITE(06.*)' FRRUK IN WRITING POPULATION PT', NPTEMP,' ONTO
& REVISED SAMPLE DATA BASE, PROCEEDING.'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE(06,3487)NPTEMP,IPINST,CMCF,IABS(1D),(TEMPV(K2))

ACHEB(K2),K2-1,MING(10,8))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ITEMPMV(K3+ISETNAM*2+ID)=ITEMPMV(K3+ISETNAM*2+ID)+1
IF(ITEMPMV(ID).NE.O.OR.ITEMPG.LE.1) GO TO 3464
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ITEMPMV(K3+ISETNAM*3+ID)=ITEMPM (K3+ISETNAM*3+ID)+1
IF(ITEMPV(ID).NE.0.0R.ITEMPO.NE.1) GO TO 3488
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ITEMPMV(K3+ISETNAM+5+ID) = ITEMPMV(K3+ISETNAM+5+ID)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ITEMPMV(K3+1SETNAM+4+1D)=1TEMPMV(K3+1SETNAM*4+1D)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ITEMPMV(K3+ISETNAM+ID)=ITEMPMv(K3+ISETNAM+ID)+1
IF(ITEMP0.NE.0) GO TO 3463
ITEMP6=ITEMP6+1
                                                                                                                                                                                                                                                                                                                                                                                                              ITEMPMV(K3+ID)=ITEMPMV(K3+ID)+1
IF(ITEMPV(ID).EQ.0.OR.ITEMPC.LE.1) G0 T0 3462
ITEMP5=ITEMP5=1
                                                                                                                                                                                                                                                                                                                                                                 IF(ITEMPV(ID).EQ.0.0R.ITEMP3.NE.1) GO TO 3461
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WMITELUS.90.ERR=3480)(BUFFEMLL),L=1.INMAX)
ITEMP2=ITEMP2+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NPINSETT(IABS(ID))=NPINSETT(IABS(ID))+1
                                                 DO 3474 JEL+1, ISEINAM
IF(CHEB(N1+J), EQ.(HLI) GC 30 3478
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (CHEB(K1+J), EQ, CHEQ) GO TO 3486
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               К1=((Z+1SETNAM-ID)+(ID-1))/2-ID
DG 3481 J=IC+1,ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DU 3483 I=1,1D-1
K1=((2*ISETNAM-I)*(1-1))/2*ID-I
IF(CHEB(K1),EQ.CHEQ) GO TO 3486
                                                                                                                  IF(( EQ.1) d) 10 4477
D0 3476 I=1,L=1
K1={(2*ISETNAM I)*(I=1)).....[
IF(CHEB(K1).Eq.CHGI) d) 10 3478
IF(E.EQ.ISETNAM) GO TO 3475
A1-((2*ISETNAM ()*(E 1)) . .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF(10, EQ, ISETNAM) GO TO 3482
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF(ITEMPO.EQ.0) GO TO 3488
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF(ITEMP0.NE.0) GO TO 3484
                                                                                                                                                                                                                                                                                                                  DO 3479 K1-1,ISETNAM
ITEMPO=ITEMPO+ITEMPV(K1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             1F(1D, Eq. 1) GO TO 3485
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         3450 1F(ITEMP.EQ.U) ID=-ID
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            TEMP7=ITEMP7+1
                                                                                                                                                                                                                                                                                                                                                                                          I TEMP4= I TEMP4+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    I TEMP8 - I TEMP8 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            1 . EMP9=1 TEMP9+1
                                                                                                                                                                                                                                           ITEMPV(L)=1
CONTINUE
                                                                                                                                                                                                                3476 CONTINUE
3477 ITEMPV(L)
3478 CONTINUE
                                                                                                3474 CONTINUE
3475 TF(1 EQ.1
                                                                                                                                                                                                                                                                                          (TEMPU=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    I TEMPU=U
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 SASK CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               3483
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( IF LONE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        . GAPS
WRITE(06,3501)(ITEMPMV(K3+K2), K2=1,ISETNAM)
WAITE(NG +1) . ITEMPS, 'CORRECTABLE, NOT UNIQUE, USING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    INCORRECT CLASS, UNIQUE, USING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              . NPT-ITEMP2, ' FROM POPLATN FILES, CORRECTLY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NON REDUNDANI FROM INPUT SAMPLE FILE' FROM PO'LATN FILES, WITH ID NOT IN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                . ITEMP1+ITEMP2+ITEMP3, ' POINTS ON REVISED SAMPLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE(06,3501)(ITEMPMV(K3+ISETNAM+K2),K2=1,ISETNAM)
WRITE(06,+)' . ITEMP6.' . NO CLASSIFICATION, USING GAPS
                                                                                                                                                                                                                                                                                                                                                                      READ(05.*)NSETOUTT.(ISETOUTT(I),I=1,MINO(NSETOUTT,ISETMAX))
IF(IMODE.EQ.0)
&WRITE(06.*)NSETOUTT,(ISETOUTT(I),I=1,MINU(NSETOUTT,ISETMAX))
WRITE(06.*)' ENTER N(LE 20) THEN NAME N POPULATION POINTS TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    FROM POPLATN FILES, WITH ID IN SAMPLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            INCORRECT CLASS, NOT UNIQUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CORRECTABLE, UNIQUE, USING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             FROM POPLATN FILE, NOT CORRECTLY
                                                                                                                                                                                                                                                                                                    3491 ISETOUTT(1)=0
WRITE(06,*): ENTER N (LE', ISETMAX,') THEN ID OF N SETS TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                3496 WRITE(0G.*)
WRITE(0G.2503)(TEMP.(RSPAIR+NVMAX+K2),K2=1,MINO(10,8))
IF(10.GI.8)WRITE(06.2504)(TEMPV(NSPAIR+NVMAX+K2),K2=9,I0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(10,GT.8) w.17e(Ub,249U)(TEMPV(K2),CHEB(K2),K2=9,10)
3487 FORMAT(14,12,A),1),6(F7,4,A))
3494 GO TO 3220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE(06,3501)(ITEMPMV(K3+ISETNAM*2+K2),K2=1,ISETNAM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(06, 3501) (ITEMPNV(K3+ISETNAM*3+K2), K2=1, ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ(05 *)NPTOUTT. (IP10UTT(I), I=1,MING(NPTOUTT, 20))
IF(IMODE.EQ.0)
&WRITE(06,*)NPTOUTT. (IP10UTT(I), I=1,MING(NPTOUTT, 20))
                                                                                                                                                                    ENTER HAME OF NEXT POPULATION FILE ( ...
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (TEMPV (NSPAIR+NVMAX+I). NE.O.) GO TO 3496
                                                                                                                                                                                       READ(05.*)FILINT
IF(IMODE.EQ.0)WRITE(06,*)FILINT
IF(FILINT.EQ.FILECR) GO TO 3499
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         .ITEMP1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            . ITEMP7.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      , I TEMP4.
                                                                                                                   CLOSE(02,STATUS. "KEEP")
WRITE(06,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           . 1 TEMP2,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  No.
                                                                                                                                                                                                                                                                                   DO 3491 1=1,15E1MAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 3497 I=1, NSPAIR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     S. USING GAPS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         & SAMPLE FILE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            & SAMPLE FILE'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         3498 WRITE(UB,+) - WRITE(06,+)-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          & FILE
WRITE(06,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE(06, +)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE(06,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        & CLASSIFIED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(JG,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WHITE (UP. +)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE(06,+)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE(06, +)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE(06, +)
                                                                                                                                                                    WRITE (06,+)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              GO TO 3100
                                                                                                                                                                                                                                                            NSE10011=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 GO TO 3498
                                                                                                                                                                                                                                                                                                                                                       & EXCLUDED.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      & EXCLUDED'
                                                                                                3495 REWIND 02
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      REWIND 03
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                & GAPS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    & GAPS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          3497
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        3499
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CONTRACT CON

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WRITE(06,2430)(CHS(J1),ABS(TEMPM(K,J1)),CHV,J1,J1=1,MINO(3,NV))
IF(NV.GT.3) WRITE(06,110)(CHS(J1),ABS(TEMPM(K,J1)),CHV,J1,
J1=4,NV)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        C CHECK. REPRODUCE PLAME/PT DISTANCE USING PLANES IN INPUT VARIABLES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 4040 J=1,NV

DO 4040 K=1,NSPAR

TEMPM(K,J)=TEMPM(K,J)/SVAR(J)

WRITE(06,*) 'HYPERPLANES FOR SET DISCRIMINATION, IN TERMS OF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DISTANCE (RMS) TO POINT, NORMAL TO
                                                                                                                       SETS. 14. NEW SETS)')
WRITE(06.3493) SET ID' (ISETID(I), I=1, ISETNAMP)
WRITE(06.3493) POINTS PER SET', (NPINSETT(I), I=1, ISETNAMP)
                                                                                                      OLD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 4035 J=1.NV
TEMPV(K)=TEMPV(K)+TEMPM(K,J)*(-STYP(J)/SVAR(J)-CGTOT(J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE(06,2410)I,P(1,K)-TEMPV(K),J,P(NVP3-1,K)-TEMPV(K)
                                                                           ₩RITE(06,350U)FILINR,ISETNAM,ISETNAMP-ISETNAM
3500 FORMAT(' PUINTS ON REVISED SAMPLE FILE ',AB,' (',14,'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SAMPLE PLANES APPLIED TO URIGINAL SAMPLE
WRITE(Ub.3501)(ITEMPMV(k3+ISETNAM*S+K2),K2=1,ISETNAM)
FORMA1(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IUSES ORIG PT NUMBERS, NOT INCLUDED PT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE(06,2450)((1,J,J=1+1,1SETNAM),1=1,1SETNAM-1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(IDIGIT(10117->, 10MAXS-11). EQ. 0) GO TO 4100
                                                                                                                                                                                                                                                                                                                                                                                        DG 4020 L=1,ABS(1.00)*P(NVP3,K))
4020 TEMPM(K,J)=TEMPM(K,J)*P(L+1,K)*AXTOT(L,J)
4030 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    4065 READ(01,90,END=4067)(BUFFER(L),L=1,INMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(TEMPM(K,I1),GE.0.) CHS(I1)=CHP
IF(TEMPM(K,I1),LT.0.) CHS(I1)=CHM
                                                                                                                                                                                                                                                                                   NSPAR = I SETNAM + (I SETNAM - 1)/2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE(06,*)' POINT SET (
& PLANES (E=ERROR,B=BAND)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            & FILES, NO EXCLUSIONS WRITE(06,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 4060 I=1, ISETNAM-1
DO 4060 J=I+1, ISETNAM
                                                                                                                                                                                                                                                                                                            DO 4030 K=1,NSPAR
DO 4030 J=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 4035 K=1,NSPAR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   & INPUT VARIABLES
                                                                                                                                                                                                          FORMAT(A16.916)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 4050 11=1,NV
                                                                                                                                                                                                                                                                                                                                                                    TEMPM(K,J)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE(06, +)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE(Go, +)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TEMPV(K)=0.
                                                                                                                                                                                                                                     GO TO 4000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    & NUMBERS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 4060 CONTINUE
                                                                                                                                                                                                          3493
                                                                                                                                                                                                                                                                                      4000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         1035
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             4050
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TO OMIT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        1 STAT= '
                                                                                                                                                                                                                                                                                                                                               F(NSPAR.GT.B) WRITE(06,2490)(TEMPV(K+NSPAR), CHBLI, K=9, NSPAR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          411U CALL CONCAT(FILENAME,1,FILEHO,1,8)
CALL PCREAT(FILENAME,(NSPAIR*(NVMAX+4)+319)/320.3,0.15TAT.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ISETID(1), ISETID(J), CONSTANTS FOR PAIR OF PLANES, COEFFICIENTS 4150 WRITE(06,*)* NAME INPUT, OUTPUT HYPERPLANE FILE (***)* ON TO ON
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      . ( 1 I WO OL ..
                                                                                                                                                                                                                                             DO 4070 J=1,NV
4070 TEMPV(K1+NSPAR)=TEMPV(K1+NSPAR)+TEMPM(K1,J)*BUFFER(IN(J))
WRITE(O6,2480)1,ID,14,(TEMPV(K+NSPAR),CHBL1,
8 K=1,MINO(NSPAR,B))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             . ERROR OPENING INPUT HYPERPLANE FILE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE(U6,+)' NAMING OUTPUT HYPERPLANE FILE ', FILEHO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE(06,*) NAME INPUT,OUTPUT HYPERPLANE FILE ('READ(05,*)FILEHI,FILEHO IF(IMODE.EQ.O)WRITE(06,*)FILEHI,FILEHO IF(FILEHO.EQ.FILECR) GO TO 6000 IF(FILEHI.EQ.FILECR) GO TO 4110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  OPEN(07,FILE=FILEMO,STATUS="NEW",IUSTAT=ISTAT,
ACCESS="SEQUENTIAL",FORM="FORMATTED")
IF (ISTAT,NE.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE(06,+) . NAME OUTPUT HYPERPLANE FILE (''
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        UPEN(U4,FILE=FILEHI,STATUS='OLD',10STAT=ISTAT,
&ACCESS='SEQUENTIAL',FORM='FORMATTED')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(FILEHO, 3063) (TIMEOUT-TIMEIN) *3600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    C WRITE HYPERPLANES ON FILEHO IN FORMAT:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(IMODE.EQ.G)WRITE(06,*)FILEHO IF(FILEHO.EQ.FILECR) GO TO 6000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 4110 INQUIRE(FILE=FILEHO, EXIST=EXIS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(ISTAT.EQ.0) GO TO 4120
WRITE(UG.3057)FILENAME.ISTAT
IF(IMODE.EQ.1) GO TO 4111
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  & TEMPMV(NSPAIR*NVNLMAX+1))
                                                                     DO 4066 13=1,1SETNAM
1F(ISETID(13).EQ.ID) 14=13
                                                                                                                                                                                                                                                                                                                                                                                                                       CALL ATFILE(FILIN, NFILE)
IF(NFILE.NE.O) GO TO 4065
                                                                                                                                         DO 4070 I1=1, ISETNAM-1
DO 4070 I2=I1+1, ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (ISTAT.NE.O) THEN WRITE(06.4) ' ERROR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL PTIME(TIMEOUT)
ID-BUFFER(1SETVAR)
                                                                                                                                                                                                                        TEMPV(KI+NSPAR)=Ü.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             READ(05, +)FILEHO
                                                                                                                                                                                                                                                                                                                                                                                                   NFILE=NFILE+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              GO TO 4112
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ISTAT
                                                                                                                         CONTINUE
                                                                                                                                                                                                 K1=K1+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              4112
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      4111
                                                                                                                         4066
                                                                                                                                                                                                                                                                                                                                                                                                     40e7
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ISTAT=
                                                                                                                                              IF (IMODE.EQ.1) THEN
WRITE(O6.*) OUTPUT HYPERPLANE FILE , FILEHO,
"ALREADY EXISTS."
WRITE(O6.*) ENTER 1 TO OVERWRITE OR 2 TO ENTER NEW NAME."
READ(O5.*) IOVERW
IF (IOVERW.NE.1 .AND. IOVERW.NE.2) THEN
WRITE(O6.*) 'MUST ENTER 1 OR 2. PLEASE TRY AGAIN.'
GO TO 4115
                                                                                                                                                                                                                                                                                                                                        F (IOVERW.EQ.1) THEN
OPEN(07,FILE=FILEHO,STATUS='OLD',IOSTAT=ISTAT,
ACCESS='SEQUENTIAL',FORM='FORMATTED')
IF (ISTAT.NE.0) THEN
WRITE(UD,*) ERROR OPENING OUTPUT HYPERPLANE FILE.',
ISTAT=',ISTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (IMUDE.EQ.U) THEN
CALL PTIME (TIMEOUT)
WRITE(FILINI, 3063)INT((FIMEOUT-TIMEIN)*3600.*1000.)
WRITE(FILINI, 3063)INT((FIMEOUT-TIMEIN)*3600.*1000.)
WRITE(06,*) NAMING OUTPUT HYPERPLANE FILE 'FILEHO OPEN(Û', FILEHO OPEN(Û', FILEHO OPEN(Û', FORMATIED')
IF (1STAT.NE.U) THEN
WRITE(06,*) 'ERROR OPENING OUTPUT HYPERPLANE FILE.',
ISTAT=', ISTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          END IF
IF (10VERW.EQ.2) THEN
WRITE(06,*) 'ENTER NAME OF OUTPUT HYPERPLANE FILE'
(''' IF NONE)'
WRITE(06,*) - ERROR OPENING OUTPUT HYPERPLANE FILE. ISTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ(05,*) FILEHO
1F (FILEHO.EQ.FILECR) GO TO 6000
GO TO 4110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 4121 JJ=1,NV
TEMPM(NSPAIR+1,JJ)=TEMPM(K,JJ)
DO 4122 JJ=1,INMAX
TEMPM(K,JJ+4)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TEMPM(K, 3)=P(1, K)-TEMPV(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 4125 I=1, ISETNAM-1
DO 4125 J=1+1, ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ITEMPM(K,1)=!SETID(1)
ITEMPM(K,2)=!SETID(J)
                                                                                                                              IF (EXIS) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         STOP
                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               END IF
                                                               STOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           K=K+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            4122
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       4121
                                                                                                                                                                                                                 4115
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WRITE(06,+)' CHOOSING 3LD PLANES WITHOUT COMPARISON WITH NEW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                C LINKC BEGINS FREEDOMESTANDS TO THE PROPERTY OF THE PROPERTY OF THE CONTRACTOR OF T
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     GO TO 4130
4148 WRITE(06,4147)I.J
4147 FORMAT(' CHOOSE TO SAVE OLD, NEW PLANES (0,N) FOR SETS', 14,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE(07,*) (ITEMPM(* J), J=1 21 (TEMPM(K, J), J=3, INMAX+4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          & GO TO 4145
IF(ISETID(1).EQ.IBUFFER(2).AND.ISETID(J).EQ.IBUFFER(1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF(ISETID(I).EQ.IBUFFER(1).AND.ISETID(J).EQ.IBUFFER(2))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ(04, . END=4170)(18UFFER(L), L=1,2), (BUFFER(L), L=3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE(06,*) " HYPEMPLANE OUTPL" FILE WRITTEN CLOSE(04,STATUS="KEEP") CLOSE(07,STATUS="KEEP")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(TEMPM(K,JJ).NE.BLFFER(JJ)) GO TO 4148
TEMPM(K,4)=P(NVPG-1,r,-TEMPv(R)
DO 4123 JJ=1,NV
4123 TEMPM(K,4+IN(JJ))=TEMPM(NSPAIR+1,JJ)
4125 CONTINUE
                                                                                                                                                                                                                                                                                                                                    JO 70 4170
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     4200 IF(FILEMI.NE.FILEUR, REWIND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (CHCF. EQ. CHN) GO TO 4130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          8'.'.14)
IF(IMODE.Eq.1) GO TO 4149
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ITEMPM(KK, 1) = IBUFFER(1)
ITEMPM(KK, 2) = IBUFFER(2)
DO 4165 J=3, IFMAX+4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 4150 JJ=3,INMAX+4
4150 TEMPM(K,JJ)=BUFFER(JJ)
GO TO 4130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ITEMPM(K,2)=IBUFFER(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            4155 ITEMPM(K,1)=IBUFFER(;)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 4140 I-1, ISETNAM: DO 4140 J=I+1, ISETNAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               4165 TEMPM(KK,J)=BUFFER(J, GO TO 4130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           4145 DO 4146 JJ=3, INMAX+4
                                                                                                                                                                                                                                                                                                                              1F(FILEMI.EQ.FILEUF
4130 DO 4135 K=1,INMAX+4
4135 BUFFER(K)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                4149 READ(05,+)CHCF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                4170 DQ 4180 K=1,KK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             AXLENG(1)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            & GO TO 4145
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        GO TO 4160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 GO TO 4155
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      8. INMAX+4)
K=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   REWIND 07
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            4180 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               4140 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            4146 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CHCF = CHO
                                                                                                                                                                                                                                                                                KK=NSPAR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            4160
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C CALC SDIST MATRIX OF STEPPING STONE DISTANCE BETWEEN PTS, NP*NP CALC IDIST MATRIX OF ASSOCIATED NUMBER OF STEPS BETWN PTS, NP*NP C COMPUTE IFRONT MATHIX OF FRONTIER PT GOING FROM I(ROW) TO J(COL) C SDISTMX IS THE MAX SS DIST BETWEEN AND TWO POINTS.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     040 CONTINUE

050 READ(1FSD0, END=c210) (BUFFER(K), K=1, NP)

WRITE(1FSD0, END=c210) (SD1ST1(K), K=1, NP)

WRITE(1FD0, END=c210) (SD1ST1(K), K=1, NP)

WRITE(1FD0, END=c210) (ID1ST1(K), K=1, NP)

READ(1F1FR0, ENE=c210) (1BUFFER(K), K=1, NP)

READ(1F1FR0, END=c210, ERR=c210) (1BUFFER(K), K=1, NP)

READ(1F1FR0, END=c210, ERR=c210) (1BUFFER(K), K=1, NP)

WRITE(1F1FR0, END=c210, ERR=c210) (1BUFFER(K), K=1, NP)

WRITE(1F1FR0, END=c210, ERR=c210) (1D1ST1(K), K=1, NP)

READ(1F1D0, END=c210, ERR=c210) (1D1ST1(K), K=1, NP)

READ(1F1R0, ERR=c210) (1D1ST1(K), K=1, NP)

READ(1F1R0, ERR=c210) (1D1ST1(K), K=1, NP)

READ(1F1R0, END=c210, ERR=c210) (1D1ST1(K), K=1, NP)

READ(1F1R0, ERR=c210) (1FRONTIR(K), K=1, NP)

READ(1F1R0, ERR=c210) (1FRONTIR(K), K=1, NP)

READ(1F1FC0, END=c210, ERR=c210) (1FRONTIR(K), K=1, NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 130 ICHANGE2=0
DO 6200 1=1.NP
CALL DATIM(DATE1,TIMES1)
IF(1.EQ.1) GO TO 6060
IF(1.EQ.2) GO TO 6050
DO 6040 L=1,L-2
READ(IFSDO,END=6210,ERR=6210)(BUFFER(K),K=1,NP)
WRITE(IFSDN,ERR=6210)(BUFFER(K),K=1,NP)
WRITE(IFRO,END=6210,ERR=6210)(IBUFFER(K),K=1,NP)
WRITE(IFRO,END=6210,ERR=6210)(IBUFFER(K),K=1,NP)
READ(IFIRO,END=6210,ERR=6210)(IBUFFER(K),K=1,NP)
READ(IFIRO,END=6210,ERR=6210)(IBUFFER(K),K=1,NP)
READ(IFIRO,END=6210,ERR=6210)(IBUFFER(K),K=1,NP)
READ(IFIRO,END=6210,ERR=6210)(IBUFFER(K),K=1,NP)
READ(IFIRO,END=6210,ERR=6210)(IBUFFER(K),K=1,NP)
READ(IFIRO,END=6210)(IBUFFER(K),K=1,NP)
                                                                                                                                                                                                                                                                                               | JFRONTIR(L) = 0
| JFRONTIC(L) = 0
| WRITE(14.ERR=62:3)(| JFRONTIR(K), K=1,NP)
| WRITE(15.ERR=62:3)(| JFRONTIC(K), K=1,NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL DATIM(DATE: TIMES)
CLSECDEL=120.
CLSECDLI=120.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    6180 J=I+1,NF
                                                                                                                                               DO 6020 L=1,NP
DO 6010 K=1,NF
                                                                                                                                                                                                                            IFRONTIR(K)=L
6010 IFRONTIC(K)=K
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  I CHANGE 1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IFSD0=12
IFIDN=23
IFID0=13
IFIFRN=24
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IFIFRO=14
IFIFCN=25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            REWIND 14
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   REWIND 15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IFIFCO=15
                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   6040
                                                                                                                                                                                                                                                                                                                                                                                                                                                      6020
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IFRONTJC(I)=IFRONTIR(J)
IF(SDIST1(IFRONTKJ).LT.SDISTI(IFRONTLJ))IFRONTIR(J)=IFRONTKJ
IFRONTJC(I)=IFRONTIR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF(SDISTI(IFRONTIK).LT.SDISTI(IFRONTIJ)))IFRONTIK(J)=1FRONTIK
IFRONTJC(I)=IFRONTIR(J)
IF(SDISTJ(IFRONTKI).LT.SUISTJ(IFRONTJI))IFRONTJR(I)=IFRONTKI
IFFSONTIC(J)=IFRONTJR(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(SDISTI(K) SDISTJ(K) 6090,6100,6110
6090 IF(SDISTI(IFKUNTKJ).LT.SDISTI(IFRONTIJ))IFRONTIR(J)=
&IFRONTJC(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    !FRONTJC(1)=IFRONTIR(J)
IF(SDISTJ(IFRONTJK).LT.SDISTJ(IFRONTJI))!FRONTJR(I)=
k!FRONTJR(k)
IFRONTIC(J)=IFRONTJR(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IFRONTIC(J)=IFRONTJR(I)
IF(SDISTJ(IFRONTJI))IFRONTJR(I)=
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(SDISTJ(IFRONTJK).LT.SDISTJ(IFRONTJI))IFRONTJR(I)=
&IFRONTJR(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      GU TO 6160
6100 IF(SDISTI(IFRONTIK)_LT.SDISTI(IFPONTIJ))IFRONTIR(J)=
READ(IFSDO.END=6210,ERR-6210)(SDISIJIR).K=1,NP)
READ(IFIDO.END-6210,ERR=6210)(IDISIJIR),K=1,NP)
READ(IFIFRO.END=6210,ERR-6210)(IFRONTJR(K),K=1,NP)
READ(IFIFCO.END=6210,ERR=6210)(IFRONTJR(K),K=1,NP)
II=I
                                                                                                                                                                                                                                                                                                                                                                                                                            TSDISTIJ=AMIN!(TEMPU,TEMP!)

IF(TEMPO-TEMP!) 6160,6070,6120
6070 IF(ITDISTIJ-IDISTI(K)-IDISTJ(K))6160,6080,6120
6080 IFRONTIJ=IFRONTIR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF(SDISTI(K)-SDISTJ(K)) 0130,6140,6150
IFRONTIR(J)=IFRONTJC(K)
                                                                                                                                                                                                                                                                                                                                                                                TEMP1=AMAX1(SOISTI(K), SUISTU(K))
                                                                                                                                                                                                                                                                                                   DO 6160 K=1,NP
IF(K.EQ.I.0R.K.EQ.J) GO TO 6160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               (A) - IDISTI(K) + IDISTI(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IFRONTIC(J)=IFRONTJR(I)
G0 T0 6160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IFRONTJC(I)=IFRONTIR(J)
IFRONTJR(I)=IFRONTJR(K)
IFRONTIC(J)=IFRONTJR(I)
GO TO 6160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IFRONTIR( ) = IFRONTIR( )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IFRONT JI - IFRONT JR (I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IFRONTIK-IFRONTIR(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   I FRONTK I = I FRONT I C ( K )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IFRONTJK=IFRONTJR(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    I FRONTKU - I FRONTUC (K)
                                                                                                                      Jiej
Luelvectr(II, J:)
ITDISTLUEIDISTI(J)
TSDISTLUESDISTI(J)
ITEMPIEIFRONIUR(U)
ITEMPZEIFRONIUR(U)
                                                                                                                                                                                                                                                                                                                                                                                                       TEMPO=TSDISTIJ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           OIFRONTIR(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               &IFRONTIC(K)
                                                                                                                                                                                                                                                                              ITEMP=0
                                                                                                                                                                                                                                                                                                                                                    X 1=K
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0119
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             6130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     6120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           6140
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CLSECI=(TIMECI-TIMESI)*3600.
IF(CLSECI.LT.CLSECDLI) GO TO 6200
WRITE(06,6195)ICHANGE).I.ICHANGE2
6195.FORMAT(' ON CLUSTER ITERATION',13', TO POINT',15,', CHANGED'
8,13', SS DISTANCES')
6200 CONTINUE
                                                                                                                                                                            IF(ITEMP1.NE.1FRONTIR(J).OR.ITEMP2.NE.IFRONTJR(I))ICHANGE2=
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL DATIM(DATE), TIMEC)
CLSEC=(TIMEC-TIMES)*3600.
IF(CLSEC.T.CLSECDEL) GO TO 6030
WRITE(06.6205)ICHANGE1, ICHANGE2
6205 FORMAT('ON CLUSTER ITERATION', I3,', CHANGED', IB,' STEPPING
                                                                                                                                                                                                                                                                                            SDISTMX=AMAX1(SDISTMX,TSDISTIJ)
SDISTMX=AMAX1(SDISTMX,TSDISTIJ)
SDISTJ(I)=ITDISTIJ
WRITE(IFSDN,ERR=6210)(SDISTJ(K),K=1,NP)
WRITE(IFIDN,ERR=6210)(IDISTJ(K),K=1,NP)
WRITE(IFIFRN,ERR=6210)(IFRONTJR(K),K=1,NP)
WRITE(IFIFRN,ERR=6210)(IFRONTJR(K),K=1,NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE(06,6206)(TIMEC-TIMES)/60,
FORMAT(' USING', F6.1, ' MINUTES')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(ICHANGE2.EQ.U) GO TO 6220
                                                                                                                                                                                                &ICHANGE2+1
IF(ITEMP.EQ.0) GO TO 6170
ICHANGE2=ICHANGE2+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL DATIM(DATE), TIMECI)
IFRONTJC(I)=IFRONTJR(I),
IFRONTJR(I)=IFRONTJR(K)
IFRONTIC(J)=IFRONTJR(I)
GO TO 6100
                                                                          IFRONTIR(J)=IFRONTIR(K)
IFRONTJC(I)=IFRONTIR(J)
IFRONTJR(I)=IFRONTIC(K)
IFRONTIC(J)=IFRONTIC(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           I CHANGE 1 = I CHANGE 1 + 1
                                                                                                                                                                                                                                                            SDISTI(J)=TSDISTIJS
SDISTI(I)=TSDISTIJ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             REWIND IFIDO
REWIND IFIFRN
REWIND IFIFRO
REWIND IFIFCN
REWIND IFIFCN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         FIFRN=IFIFRO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             FIFRO=ITEMPU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IFIFCN=IFIFCO
IFIFCO=ITEMPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TEMPU=1F1FRN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  TEMP0=IFIFCN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IFSDO
IFIDN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       I F SD0 = 1 T EMP0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   REWIND IFSON
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ITEMPO-IFSDN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ITEMPO=IFIDN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IFIDN=IFIDU
IFIDO÷ITEMPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       I F SDN = I F SDC
                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        6206 FORMAT(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       REWIND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            REWIND
                                                                                                                                                           င် 1 စိပ
                                                                            6150
                                                                                                                                                                                                                                                            6170
                                                                                                                                                                                                                                                                                                                                                                                                                                            6130
6190
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WRITE(06,+), MATRIX OF STEPPING STONE DISTANCES BETWEEN POINTS:
DO 6250 I=1,NP
6210 WRITE(06,*)' STOP. 10 ERROR IN HANDLING SDIST, IDIST, IFRONT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (UD, +) MATRIX OF FRONTIER POINTS GOING FROM POINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(06,+)' MATRIX OF COUNT OF STEPS BETWEEN POINTS DO 6290 I=1,NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(06, 60) (IBIIFFER(K), K=IPRINT, MINO(NP, IPRINT+14))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ(IFIFRN, END=6360, ERR=6360) (IBUFFER(K) ..=1, NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF(NP.GT.15) WRITE(06.*) ROW., I
READ(IFIDN, END=6300, ERR=6300) (IBUFFER(K), K=1,NP)
WRITE(06,60) (IBUFFER(K), K=1,NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                GO TO 6370
WRITE(Ub,*) 'NUTE, ERROR IN READING IFRONI FILE.
REWIND IFIFRN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(NP.GT.10) WRITE(06,*) ROW', I
READ(IFSDN,END=6260,ERR=6260)(BUFFER(K),K=1,NP)
WRITE(06,70)(BUFFER(K),K=1,NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE(06,*)' NOTE. ERROR IN READING SDIST FILE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE(06,*)" NUTE, ERKUR IN READING IDIST FILE.
REWIND IFIDN
                                                                                                                                                                                                                                                                                                                                       CLOSE(12,STATUS='DELETE')
CLOSE(13,STATUS='DELETE')
CLOSE(14,STATUS='DELETE')
CLOSE(15,STATUS='DELETE')
IF(IDIGIT(IOUTPC,IOMAXC-1),EQ.0) GO TO 6280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF(IDIGIT(IOUTPC, IUMAXC-2).EQ.0) GO TO 6320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF(IDIG*1(1001PC,10MAXC-3),EQ.0) GG 10 6370
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        & (ROW) TO POINT J (COLUMN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(IPRINT, LE, NP) GO TO 6330
                                                                                                                                                                                                                      6230
                                                                                                                                                                                                             6220 IF(IFSD0.EQ.12) GO TO 6230
CLOSE(22,STATUS="DELETE")
CLOSE(23,STATUS="DELETE")
CLOSE(24,STATUS="DELETE")
CLOSE(24,STATUS="DELETE")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IPRINT = IPRINT + 15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 6340 I=1,NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          REWIND IFIFRN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  REWIND IFSON
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE(06, *)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE(06,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       TO 6310
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           10 6270
                                                                                                                                                                                                                                                                                                                      GO TO 6240
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                             K FILES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  6270
6280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           6310
6320
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           6260
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                                                                                                                                                                                                                                                                                                                                           6230
                                                                                                                                                                                                                                                                                                                                                                                                                            6240
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      6250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  6290
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0360
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C CALC IPINCL VECTOR, IPINCL(I) IS CLUSTER I (ROW)
C CALC IPINCL VECTOR, IPINCL(I) IS CLUSTER TO WHICH POINT I BELONGS
IN ICLUSTER & IPINCL INTERIOR POINTS ARE -, OTHERS ARE FRONTIER
C POINTS. PRINCL(I) IS COUNT OF POINTS IN ITH CLUSTER, ICLNAME IS
C COUNT OF CLUSTERS. SDISTC IS MATHY OF SS DISTANCES BETWEEN
C CLUSTERS WITH DIAGONALS THE MAX SS DIST WITHIN CLUSTERS.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 6500 I=1,NP
IF(ICLUSTER(ICLNAME,I),NE.1) GO TO 6500
PICK FIRST UNPROCESSED POINT IN CLUSTER, CALL IT II, RETURM TO
                                                                                                                                                                                                                                                                                                                                                                                                                                               C MARK PT II WITH -1 INDICATING IT IS PROCESSED OR ABOUT TO 6400 ICLUSTER(ICLNA:AE,II) = 1
IF(IBOND(II).EQ.3) GO TO 6410
IF(ICLUSTER(ICLNAME,IBOND(II)).EQ.0)ICLUSTER(ICLNAME,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF(ICLUSTER(ICLNAME, JJ).NE.0) GO TO 6490
ICLUSTER(ICLNAME, JJ)=1
IF(IBOND(JJ) EO.0) GO TO 6480
IF(ICLUSTER(ICLNAME, IBOND(JJ), EQ.0)ICLUSTER(ICLNAME,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     6410 IF(JBÖND(II), EQ.0) GO TO 6420
IF(ICLUSTER(ICLNAME, JBOND(II)), EQ.0)ICLUSTER(ICLNAME
&JBOND(II))=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (ICLUSTER (ICLNAME, JBOND (JJ)), EQ. 0) ICLUSTER (ICLNAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   6440 READ(IFIFRN, END=6460, ERR=6460)(IBUFFER(K), K=1,NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ(IFIFRN, END=6460, ERR=6460)(IBUFFER(K), K=1,NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF(J.EQ.II) NO TO 6490
C PUT FRONTIER POINTS BELONGING TO II INTO ITS CLUSTER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GO TO 6470
6460 WRITE(06,*)' ERROP IN READING IFRONT FILE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF(ICLUSTER(ICLNAME, II).NE.0) GO TO 6550
DO 6530 L=1,IABS(IFLOCR-II)
IF(II-IFLOCR) 0510,6530,6520
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           6480 1F(JBOND(JJ), EQ.0) GO TO 6490
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       6420 DO 6450 L=1, IABS(IFLOCR-II)
IF(II-IFLOCR) 6430,6450,6440
6430 BACKSPACE IFIFRN
                                                                                                                                                                                                                                                    DO 6380 1=1,ICLMAX
ICLUSTER(I,J)=0
DO 6390 I=1,NPMAX
                                                                                                                                                                                                                                                                                                                                      1=((r)QNOB()gNOBC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 6550 II=1,NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 6490 J=1,NP
                                                                                                                                                                 6370 DO 6380 J=1,NP
IPINCL(J)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      JJ-IBUFFER(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   4.180ND(JJ))=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              &IBOND(II))=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 $180ND(JJ)=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IFLOCR=11+1
                                                                                                                                                                                                                          JBOND( ) =0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               GO TO 6450
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               GO TO 6400
                                                                                                                                                                                                                                                                                                                                                                  I CLNAME= 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  6450 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                        IFLOCR=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             $T0P 7
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      C PROCESS 11
                                                                                                                                                                                                                                                                                6380
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          6490
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    6470
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           6500
                                                                                                                                                                                                                                                                                                                                      6390
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IF(JO.EQ.KMAX.GR.IO.EQ.KMAX) GO TO 6730
IF(ICCHNAME+H.LE.ICLMAX) GO TO 6670
WRITE(OG.*) ALLOWABLE NUMBER OF CLUSTERS PREVENTS SUBDI.ISION
                                                                                                                                                                                                                                                                                                                                                                 FRONTIER IN GOING TO ANY OTHER SUBCLUSTER, LOOK FOR SUBMATRICES OF IFRONT HAVING THE MOST IDENTICAL ENTRIES FOR 18.9 BELONGING TO CLUSTER. (LOOP TO 6710) THEN FIND THE COLUMNS WITH DUPLICATE ENTRIES. (6660 TO 6710)
                                                                                                                                                                                                                                                                                                                                               FIND SUBCLUSTERS OF LAST CLUSTER. POINTS IN SUBCLUSTER HAVE SAME
                                                                                                                                                                    C CLUSTER, CALL IT 11, PUT IN CLUSTER, CALL IT 11, PUT IN C CLUSTER, ETC
                    GO TO 6530
6520 READ(IFIFRN, END=0460, ERR=6460) (IBUFFER(K), K=1,NP)
6530 CONTINUE
                                                                                    READ(IFIFRN, END=6460, ERR=6460) (18UFFER(K), K=1, NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ(IFIFCN,END=0720,ERR=6720)(IBUFFER(K),K=1,NP)
DO 6620 K=J,KMAX
                                                                                                                                                                                         IF(ICLUSTER(ICLNAME, IBUFFER(J)).NE.0) GO TO 6400 6540 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF(ICLUSTER(ICLNAME, K))6500,6620,6600
IF(IBUFFER(I)-IBUFFER(K))6520,661C,6620
KOUNT=KOUNT+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF(ICLUSTER(ICLNAME,I).EQ.0) GO TO 6570 KMIN=MINU(KMIN,I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF(ICLUSTER(ICLNAME, 1))6580,6650,6580
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DU 6640 J=KMIN, KMAX
IF(ICLUSTER(ICLMAME, J))6590,6640,6590
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL FILELOC(IF:FUN,IFLOC,IFLOCN)
IFLOC=IFLOCN+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF(KOUNT.LE.KOUNTO) GO TO 6640
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF(KOUNTO.GT.1) GO TO 6660
                                                                                                                                                  IF(11.EQ.J) GO TO 6540
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    . ICLNAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 665U I=KMIN, KMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             KMAX=MAXO(KMAX,I)
CONTINUE
                                                                                                    IFLOCR=11+1
DO 6540 J=1,NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DU 657U 1=1 NP
                                                                                                                                                                                                                                                                               REWIND IFIFRN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    & OF CLUSTER",
H=H-1
GO TO 6730
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DOGG KOUNTO-KOUNT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         KOUNTO=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          I FLOCN = J
                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                 IFLOCR=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONT I NUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                6560 KMIN=NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    D= I NOOY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IFLOC= 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    6600
6610
6620
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6650
6510
                                                                                                                                                                                                                                                         6550
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   6570
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       6580
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    URCQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      0999
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IFLOC=IFLELOC(IFIFCN, IFLOC, IFLOCN)
IFLOC=IFLOCN+1
READ(IFIFCN, END=6720, ERR=6720) (IBUFFER1(K), K=1, NP)
00 6680 K=10, KMAX
IF(ILUSTER(ICLNAME, K), EQ.0) GO TO 6680
IF(IBUFFER(K), NE, IFRONTO) GO TO 6690
IF(IBUFFER1(K), NE, IFRONTO) GO TO 6690
                                                                                 READ(IFIFCN, END=6720, ERR=6720) (IBUFFER(K), K=1,NP)
IFRONTO=IBUFFER(10)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       GO TO 6730
) DO 6710 J=JO,KMAX
IF(ICLUSTER(ICLNAME,J).EQ.ICLUSTER(ICLNAME+H,J))
&ICLUSTER(ICLNAME,J)=O.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     6720 WRITE(06,*)' ERROR WHILE READING IFRONTC FILE'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
GO TO 6820
JF(I).EQ.I2) GO TO 6820
DO 6780 J=1,NP
JCLUSTER(I),J)*ICLUSTER(II,J)*ICLUSTER(I2,J)
JF(I2.EQ.ICLNAME) GO TO 6800
DO 6790 J=12,ICLNAME-1
DO 6790 J=1,NP
ICLUSTER(ICLNAME+H,JU)=ICLUSTER(ICLNAME,JU)
IFLOCN=JU
                                                                                                                                                                                                                                                                                                                                                                             ICLUSTER(ICLNAME+H, J)=ICLUSTER(ICLNAME, J)
                                                                                                                                             DO 6690 J=JO+1,KMAX
IF(ICLUSTER(ICLNAME,J).EQ.0) GO TO 6690
IFLOCN=J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 6740 K=1, ICLNAME
IF(ICLUSTER(K,J1), EQ.0) GO TO 6740
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 6760 K=1, ICLNAME
IF(ICLUSTER(K, J2). EQ. U) GO TO 6760
                                        CALL FILELOC(IFIFCN, IFLOC, IFLOCN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        COMBINE CLUSTERS THAT ARE BONDED
DO 6820 JI=1,NP
If(IBOND(J1).EQ.0) GO TO 6820
J2=IBOND(J1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                6790 ICLUSTER(I,J)=ICLUSTER(I+1,J)
6800 DO 6810 J=1,NP
                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
IF('1.NE.JO) GO TO 6700
ICLUSTER(ICLNAME+H,JO)=0.
                                                              IFLOC=IFLOCN+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 6730 REWIND IFIFCN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
GO TO 6820
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     GU TO 6560
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               GO TO 6750
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GO TO 6770
                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        6710 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             6760
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              6780
   6670
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      6770
                                                                                                                                                                                                                                                                                                                                                         6680
                                                                                                                                                                                                                                                                                                                                                                                                                       0699
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              6700
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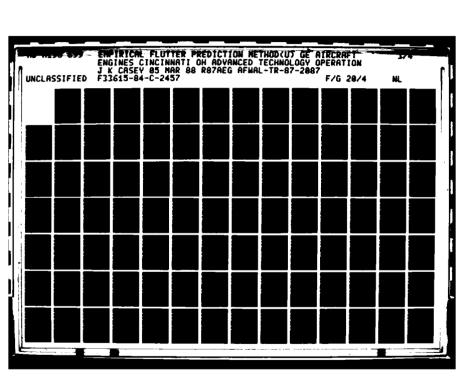
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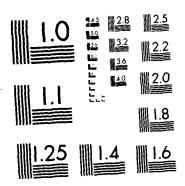
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D0 6900 J=1,NP
D0 6900 I=1,ICLNAME
IF(ICLUSTER(I,J).EQ.0) G0 T0 6900
IF(IPINCL(J).NE.0) WRITE(06,*)' POINT ',J,'BELONGS TO CLUSTER
IF(IPINCL(J).NE.0) WRITE(06,*)' POINT ',J,'BELONGS TO CLUSTER
IPINCL(J)=-I
                                                                                                                                                                                                          WRITE(06.+)' MORE CLUSTERS THAN ALLOWED BY DIMENSION:', ICLMAX GO TO 6890
ICLNAME=ICLNAME+)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF(IPINCL(!),LT.0) GO TO 6940
IF(IPINCL(!),EU.0) WRITE(06,*)* ERROR. POINT ',I,* UNASSIGNED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF(I.EQ.J) GO TO 6910
IF(IABS(IPINCL(I)).EQ.LABS(IPINCL(J)).AND.IABS(IFINCL(I)).EQ.
AIABS(IPINCL(IBUFFER(J)))) GO TO 6910
IPINCL(IBUFFER(J))=IABS(IPINCL(IBUFFER(J)))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              BELONGS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (UB, aU) (IPINCL(J), J=[PRINT, MINU(NP, IPRINI+9))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NUMBER OF THE CLUSTER TO WHICH POINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     00 6910 1=1,NF
READ(IFIFRN,END=6920,ERR=6920)(IBUFFER(J),J=1,NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                & 10 CLUSTER | INTER | INTER (IPINCL(I), I) = IABS(ICLUSTER (IPINCL(I), I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                GO TO 6930
6920 WAITE(06,*)' ERROR WHILE READING IFRONTR FILE'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                6940 CONTINUE
IF(IDIGIT(10UTPC,10MAXC-4) EQ.0) GO TO 7010
                                                                                                                                            IF(ICLUSTER(I,J),NE.0) GO TO 6850
                                                                                                                                                                                                                                                                                                                                                                                          C COMBINE IF ONLY ONE POINT PER CLUSTER
                                                                                                                                                                                            IF(ICLNAME.LT.ICLMAX) GO TO 6840
                                                                                                                                                                                                                                                                                                                                                                                                                    6860 IF(ICLNAME.NE.NP) GO TO 6890
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (ISETNAM, LE, 1) GO TO 7010
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               L (-MEANS INTERIOR POINT) ...

DO 6950 1=1, (NP+9)/10

IPRINT=1+(I·1)*10
6810 ICLUSTER(ICLNAME, JI-U
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ICLUSTER(1, J) = 1
DO 6870 I=2, ICLNAME
                                                                                                                     DO 6830 IFI, ICLNAME
                    I CLNAME = I CLNAME - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  6870 ICLUSTER(I,J)-0
6880 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 6880 J=1,NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        4N, 1=1, 0196 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         6930 DG 6940 1=1 NF
                                                                       DO 6850 J-1,NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               6910 CONTINUE
REWIND IFIFRN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE(06,*);
WRITE(06,*)
                                                                                                                                                                                                                                                                                                                 GO TO 6400
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ICLNAME = 1
                                                                                                                                                                     CB30 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              6900 CONTINUE
                                           6820 CONTINUE
                                                                                                                                                                                                                                                                                                                                          6850 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      6950 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ST0P 9
                                                                                                                                                                                                                                                                     6840
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BARRA - Responsed - The Properties of the Control o

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C FOR POINTS IN EACH CLUSTER SUBTRACT CG AND PUT IN BOTTLE
C FORM XINF INFORMATION MATRIX. THIS IS XINF WITH POINTS GROUPED BY
C CLUSTER, WITH CG OF LLUSTER SUBTRACTED, ROTATED ALONG AXES OF
C BOTTLE. AXES HAS IN EACH ROW A SEMI AXIS OF LENGTH I, UP TO NUMAX
C COLUMNS. THERE ARE NUMAX ROWS RESERVED PER CLUSTER, UP TO ICLMAX
C CLUSTERS. AXLENG HAS FORMAT OF A COLUMN OF AXES, HAS LENGTH OF
C CORR ROW OF AXES. NAINCL(K) IS THE NUMBER OF AXES IN CLUSTER K.
C THIS CODING IS USED FOR SETS AS WELL AS FOR CLUSTERS.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 7040 K=1,ICLNAME
DO 7030 KK=1,ICLNAME
DO 7030 KK=1,ICLNAME
1030 SDISTC(K,K)=SDISTMX
1040 SDISTC(K,K)=0.
DO 7050 I=1,NP
K=1485(IPINCL(I))
READ(IFSDN.END=6350.ERR=6350)(BUFFER(L),L=1,NP)
DO 7050 II=1,NP
KK=1485(IPINCL(II))
IF(K.EQ.KK) SDISTC(K,K)=AMAX1(SDISTC(K,K),BUFFER(II))
IF(K.NE.KK) SDISTC(K,K)=AMAX1(SDISTC(K,KK),SDISTC(KK,K),
8BUFFER(II))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(06,*)'
WRITE(06,*)'
WRITE(06,*)' STEPPING STONE DISTANCES FOR CLUSTERS (ON DIAG=
&WITHIN,OFF DIAG=BETWEEN)'
DO 7060 K=1,ICLNAME
WRITE(06,70)(SDISTC(K,J),J=1,ICLNAME)
                                                                                                                                6960 ITEMPV(J)=0

DO 6980 J=1,ICLNAME

DO 6976 K=1,NP

IF(IABS(IPINSET(K)).EQ.I.AND.ICLUSTER(J,K).NE.0) ITEMPV(J)=
                                                                                                                                                                                                                                                                                                                                DO 6990 J=1,(ICLNAME+9)/10
IPRINT=1+(J-1)*10
WRITE(06,80)(ITEMPV(L),L=IPRINT,MIN0(ICLNAME,ICLNAME+9))
                                 COUNT OF SET MEMBERS IN EACH CLUSTER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(IDIGIT(IOUTPC, IOMAXC-5).EQ.0) GC TO 7070
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               7010 DO 7020 I=1,ICLNAME

NPINCL(I)=0

DO 7020 J=1,NP

IF(ICLUSTER(I,J).EQ.0) GO TO 7020

NPINCL(I)=NPINCL(I)+1
WRITE(06.*)
WRITE(06.*) - LOUNT OF SET MEMBERS
DO 70G3 1=1,1SETNAM
WRITE(06.*) - SET 1D = 1SETID(1)
DO 6960 J=1,1CLNAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              7050 SDISTC(KK,K)=SDISTC(K,KK)
IF(IFSDN.EQ.12) REWIND 12
IF(IFSDN.EQ.22) REWIND 22
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NSETCL = I CLNAME
IOUTPSC = IOUTPC
                                                                                                                                                                                                                                                   AITEMPV(J)+1
6970 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                  6990 CONTINUE
7000 CONTINUE
                                                                                                                                                                                                                                                                                                      6980 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    7060 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     7030
7040
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IF(NPIN(K).GT.1) GO TO 72UU
WKITE(06,*)' SEMIAXES OF BOTTLE FOR ', CHSETCL, K, ' MULL SINCE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        7180 TEMP=TEMP+AKES(IV+I-1, J)+AXES(IV+I1-1, J)
IF(ABS(TEMP).LE.10.E-5) GO TO 7190
#MITE(06,7185)1,11,TEMP*AXLENG(IV+I-1)+AXLENC(IV+II-1)
7185 FORMAT('AXES',214,'NOT ORTHOGONAL.DOT PRODUCT IS 'E12.6)
7190 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL BOTTLE (XINF(III,1), AXES(IV,1), AXLENG(IV), NV, NPIN(K))
NAINCL(K)=0
7110 READ(10, END=7130) (BUFFER(L), L=1,NV)
C TO SCREEN DATA FROM FILE, ACTIVATE STATEMENTS AS IN S7115
C7115 IF(BUFFER(IACCEPT).NE.VACCEPT) GO TO 7110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF(IDIGIT(IDUTPSC,IOMAXC-IOUTSC-6).EQ.0) G0 T0 7230
WHITE(06,*):
                                                                                                                                                                                                                                                                                                                                                                                                           DO 7170 I=1,NV
IF(AXLENG(IV+I-1).NE.0)NAINCL(K)=I
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 7120 J=1,NY
7120 XINF(ITEMPV(K),J)=BUFFER(J)
ITEMPV(K)=ITEMPV(K)+1
IF(I.LT.NP) GO TN 7110
7130 REWIND 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       XINF(I,J)=XINF(I,J)-CG(K,J)
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CG(K,J)=CG(K,J)+XINF(I,J)
CG(K,J)=CG(K,J),TEMP
DO 7150 I=III,11
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DÛ 7190 I=1,NAÎNCL(K)-1
DO 7190 I1≃I+1,NAÎNCL(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          7200 WRITE(06,7210)CHSETCL, K
                                                                                                                                                                                                                                             DO 7100 I=2,NSETCL
7100 ITEMPV(I)=ITEMPV(I-1)+
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 7340 K=1, NSETCL
                                                                                                                     DO 7080 1=1, NAXES 7080 AXLENG(1)=0.
                                                                                                                                                           DO 7090 I=1, NAXES
DO 7090 J=1, NVMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CG(K,J)=0.
DO 7140 I=III,II
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 7160 J=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      UN 1=0 0817 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             II=II+NPIN(K)
                                                                                                                                                                                                     7090 AXES(1,J)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TEMP=NPIN(K)
                                                                                                                                                                                                                          ITEMPV(1)=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       GO TO 7240
                                                                                                                                                                                                                                                                                       8NPIN(1-1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  V POINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TEMP=0
                                                                                                    1 ^= 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               7150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  7140
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WRITE(06.*)
WRITE(06.*)
WRITE(06.*)
WRITE(06.*)
WRITE(06.*)
WRITE(06.*)
WRITE(06.*)
WRITE(06.*)

CALL PLOTSCAT (XINF(III.1), AXLENG(IV), NV, NPIN(K))

7240 IF(IDIGIT(IOUTPSC, IOMAXC-IOUTSC-8), EQ.0) GO TO 7330
WRITE(06.*)
IF(NAINCL(K), GT.0) GO TO 7250
WRITE(06.*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE(06,7300)CHSETCL,K
7300 FORMAT(* DATA TRANSFORM FROM *,A7,13, AXES (V) TO ORIGINAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(06, 100)CHV, I, TEMP, (CHS(J), ABS(AXES(IV+I-1,J)), CHU,J, 8J=1,MINO(3,NV))
IF(NV.LE 3) GO TO 7290
WRITE(06,110)((CHS(J), ABS(AXES(IV+I-1,J)), CHU,J), J=4,NV)
7290 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE(06,100,CHU,J,CG(K,J),(CHS(II),AES(AXES(IV+II-1,J)),

&CHV,II,II=1,MINO(3,NAINCL(K)))

IF(NAINCL(K),LE,3) GO TO 7320

WRITE(06,110)(CHS(II),ABS(AXES(IV+II-1,J)),CHV,II,II=4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               7360 IF(CHSETCL.EQ.CHSET) GO TO 7465
IF(IDIGIT(IOUTPSC.IOMAXC-IOUTSC-9).NE.0) WRITE(06.*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(IDIGIT(IOUTPSC.10MAXC-10UTSC-9).Eq.0) GO TO 7360 WRITE(06.*)
WRITE(06.*)
WRITE(06.*)
DO 7350 K=1,NSETCL
WRITE(06.70)(CG(K,J),J-1,NV)
                                                                                                                                                                                                         7230 IF(IDIGIT(IOUTPSC, IOMAXC-IOUTSC-7).EQ.0) GO TO 7240
FORMAT('SEMIAXES OF BOTTLE CONTAINING 'A7,16)
DO 7220 I=1, NAINCL(K)
WRITE(O6,70)(AAES(I:+I-1,J)*AXLENG(IV*I-1),J=1,NV)
                                                                                                                                               WRITE(06,70)( xLENG(IV+1-1), I=1, NAINCL(K))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 7320 J=1,NV
DO 7310 11=1,NAINCL(K)
IF(AXES(IV+I1-1,J).GE.O.) CHS(I1)=CHP
IF(AXES(IV+I1-1,J).LI.O.) CHS(I1)=CHM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(AXES(IV+I-1,J).GE.O.) CHS(J)=CHP
IF(AXES(IV+I-1,J).LT.O.) CHS(J)=CHM
7280 CONTINUE
                                                                                                                      WRITE(06,*) LENGTH OF THE SEMIAKES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 7270 J=1,NV
TEMP=TEMP-AXES(IV+I-1,J)+CG(K;J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 7290 I=1, NAINCL(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                7330 III=III+NPIN(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    VN, 1=0 0827 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    & AXES (U).)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        B, NAINCL(K))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         7310 CONTINUE
                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 7320 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 AN+AI=AI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            7340 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          7350 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        7270
        7210
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C SKIP DETERMINANT CALC DUE TO 1) DISCREP IN DIM OF TEMPM IN DETERM C & DTRMIN 2) TEMPM FOR DTRMIN IS CALC AS NP+NV, BUT DIM C IS DIFFERENT 3) TERMPM HERE OVERWREITES TEMPMV AT C S 975 4) DETERMINANT NOT CHECKED OUT ANYHOW.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             7620 FORMAT( GUADKATIC EQUATION FIT TO CLUSTER., I3, NULL SINCE
8 ONLY ONE POINT:)
GO TO 7720
7630 DO 7640 I=1,NAINCL(K)
DO 7640 J=1,HAINCL(K)
1J=NAINCL(K)
                                                                                                                                                                                                                                                       7540 FORMAT (* CORRELATION MATRIX FOR NEW COMPONENTS OF POINTS IN
                                                                                                                                                                                                                                                                                 8,47,16)
DO 7550 I=1,ITEMP
WRITE(06,70)(VAR(I,J)/SQRT(VAR(I,I)*VAR(J,J)),J=1,ITEMP)
7553 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       7590 BVOLUME=BVOLUME*AXLENG(KK+1)*2.
WRITE(06.7600)CHSETCL,CVOLUME,BVOLUME,CVOLUME,CVOLUME
7600 FORMAT(A7,' vOLUME/BOTTLE VOLUME=',E12.4,' /',E12.4,'
                                                                                                                                                                                                      IF(IDIGIT(10UTPSC,10MAXC-10UTSC-10).EQ.0) GO TO 7560 WRITE(06,7540)CHSETCL,K
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE(06.*) CVOLUME' SORT(DETER*(TEMP**ITEMP))
WRITE(06.*)K,NPIN(K),ITEMP,DETER,KOUNT,III
CVOLUME=SQRT(CVOLUME*(TEMP**ITEMP))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     7615 IF(1DIGI1(10UTP(,10MAXC-11),EQ.0) GO TO 9000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 7580 I=1, NPIN(K)
DO 7580 J=1, ITEMP
IEMPM(I,J)=XINF(III-NPIN(K)+I-1,J)
CALL DTRMIN(TEMPM,NPIN(K), ITEMP,DETER,KOUNT)
DO 7530 J=1.ITEMP

VAR(I.J)=0.

DO 7520 II=III.IIII+NPIN(K)-1

7520 VAR(I.J)=VAR(I.J)+XINF(II.I)*XINF(II.J)

VAR(I.J)=VAR(I.J)/TEMP

VAR(J.I)=VAR(I.J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 7570 J=1,ITEMP
7570 TEMPM(1,J)=VAR(1,J)
CALL DETERM (TEMPM,ITEMP,CVOLUME)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF(CHSETCL.EQ.CHCLS) GO TO 7615
CHSETCL=CHCLS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 7720 K=1, ICLNAME
IF(NPINCL(K), ST. 1) GO TO 7630
MRITE(06 +17
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 7570 I=1, ITEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 7590 I=1, ITEMP
                                                                                                                                                                         III=III+NPIN(x)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   10UTPSC=10UTP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        BVOLUME=1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   076 01 09
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     8E12.4)
7610 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              [=(r1)r11
                                                                                                                                                      75 30 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   7580
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  7595
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WRITE(06, 7680)K
7680 FORMAT(' QUADRATIC EQUATION FIT TO CLUSTER', 13, ' USING CLUSTER
8 AXES (v)')
                                                                                                                                                                                                                                                                                                                                                DO 7550 H=1,NAINCL(K)
IF(Q(H).EQ.O.) GO TO 7650
TEMPV(IJ)=TEMPV(IJ)+XINF(III-1+I,H)+XINF(III-1+J,H)/(Q(H)+*2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(06,*)' LATER 0,N NOTTO,TO TRANSFORM DATA PER CLUSTER & N AXES, N CO PER ALL DATA' READ(US,*)!CASEZ | IF(IMODE.EQ.O)WRITE(06,*)!CASEZ | IF(IMODE.EQ.O)WRITE(06,*)!CASEZ | IF(ICASEZ.EQ.O) GO TO 9140 | IF(ICASEZ.EQ.O)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       &MIND(3, NANINCL(K))
7690 FORMAT( 1=', A2, E10.3, *v(', 12,')v(', 12,')', A2, E10.3, *v(', 12,')v(', 12,')', A2, E10.3, *v(', 12,')v(', 12,')', I2,')'

8, 12,')v(', 12,')', A2, E10.3, *v(', 12,')v(', 12,')', IF(NANLINCL(K), LE.3) G0 T0 7710

WRITE(06, 7700)(CHS(1), ABS(TEMPV(1)), I1J(1), J1J(1), 1=4,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE(06,7690)(CHS(1),ABS(TEMPV(1)),IIJ(1),JIJ(1),I=1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL PTIME(TIMEOUT)

CALL DATIM(DATE1,TIME1)

WRITE(D6,9010)(TIMEOUT-TIMEIN)*3c00.,TIME1

9010 FORMAT('TIME USED:',F8.2,'SECONDS, COMPLETED AT'

&F6.2,'HOURS')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        7700 FORMAT(' ', A2, E10.3, *v(', 12,')v(', 12,')'

8, A2, E10.3, *v(', 12,')v(', 12,')', A2, E10.3, *v(', 12,')'

8.)v(', 12,')')

7710 III=III+NPINCL(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF(NSETUUT.LE.U) GO TO 9035
DO 9034 K=1,NSETUUT
IF(IBUFFER(ISETVAR).EQ.ISETOUT(K)) GO TO 9030
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ(05,*)1TEMP!
IF(IMODE.EQ.0)WRITE(06,*)ITEMP!
IF(ITEMP!.LT.1.AND.IMODE.EQ.1) GO TO 9020
IF(ITEMP!.LT.1.AND.IMODE.EQ.0) STOP 16
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ(01,90,END=905G)(BUFFER(L),L=1,INMAX)
NPTEMP=NPTEMP+1
                                                 NANLINCL(K)=(NAINCL(K)*(NAINCL(K)*1))/2
DO 7660 I=1,NAINCL(K)
DO 7660 J=1,NAINCL(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(I.NE.J) TEMPV(IJ)=2.*TEMPV(IJ)
                                                                                                                                                                                                                            IJ=NAINCL(K)*(1-1)-(\tilde{1}*(1-1))/2+J TEMPV(IJ)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF(TEMPV(1).LT.0.)CHS(1)=CHM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL ATFILE (FILIN, NFILE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DØ 7670 I=1, NANLINCL(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         C TERMINATING RUN PROCEDURE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE(06,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     5000 WRITE(06.*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CHS(I)=CHP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            7670 CONTINUE
7640 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           BOSA CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 9030
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     9020
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DATA TRANSFORMED PER AXES OF ALL DATA'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DATA TRANSFORMED PER AXES OF CLUSTER'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     BE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               9140 IF(ICLNAME.LE.1) GO TO 9170
WRITE(06.+)' ENTER U,1 IFNOT.IF ABOVE CLUSTER CG''S TO & TREATED AS POINTS'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TEMP=TEMP+(XINF(I,K)-CG(ICASE2,K))*AXES(J+ITEMP,K)
XINF(I,J)=TEMP+TEMP1/AXLENG(J+ITEMP)
                                                                                                                                                                                                                                                                                                                                                                                                                              DO 9070 K=1,NV
TEMP=TEMP+(XINF(1,K)-CGTOT(K))+AXTOT(J,K)
XINF(1,J)=TEMP+TEMP1/AXLTOT(J)
                                                                                   DO 9040 Jal,MAXJ

9040 XINF(!,J)=(BUFFER(IN(J))-STVP(J))/

8.SVAR(J)

9050 NFILE=NFILE+1

CALL ATFILE(FILIN,NFILE)

IF(NFILE.NE.O) GO TO 9030

IF(I.LT.NP) GO TO 9030

IF(I.CASE2.GT.O) GO TO 9090
9035 IF(NPTOUT.LE.0) GO TO 9039
DO 9037 K=1,NPTOUT
IF(NPTEMP.EQ.IPTOUT(K)) GO TO 9030
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 9100 J=1, NAINCL(ICASE2)
TEMP1=AMIN1(TEMP1, AXLENG(J+ITEMP))
                                                                                                                                                                                                                                                                 DO 9060 [=1,NV
IF(AXLTOT(I),EQ.0.) GO TO 9060
                                                                                                                                                                                                                                                                                                                        TEMP1=AMIN1(TEMP1, AXLTOT(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ITEMP=(ICASE2-1)*NV
DO 9120 I=1,NP
DO 9120 J=1,NAINCL(ICASE2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ITEMP=(ICASE2-1)*NV
ITEMP=MING(ITEMP,ITEMP1)
TEMP1=AXLENG(1+ITEMP)
                                                                                                                                                                                                                                                                                                                                                        (TEMP=MINO(ITEMP, ITEMP1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NV=NAINCL(ICASE2)
WRITE(06,140)
WRITE(06,*)
WRITE(06,9130)ICASE2
WRITE(06,9130)
                                                                                                                                                                                                                                                                                                                                                                         DO 9080 1=1, NP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      READ(05, +) ICASE1
                                                                                                                                                                                                                                               FEMP1=AXLTOT(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE(06,*)'
WRITE(06,140)
WRITE(06,*)'
WRITE(06,*)'
GO TO 450
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               VN,1≈N 0116 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NV=ITEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               91.30 FORMAT( '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TEMP=0.
                                                                                                                                                                                                                                                                                                      I TEMP= I
                                                                                                                                                                                                                                                                                                                                                                                                             TEMP=0
                                                     9037
                                                                                                                                                                                                                                                                                                                                                                                                                                                  9010
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       9100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  9120
                                                                                                                                                                                                                                                                                                                                         0906
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 9110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     9080
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                0606
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9170 WRITE(06, +)' ENTER 0,1,2 AS THERE ARENT, ARE MORE CASES, CHANGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  THE PRIOR ROWS OF X. A 1S DATA MATRIX OF NP1 ROWS & NV COLUMNS, EACH ROW BEING THE COORDINATES OF A PT IN NV DIMENSIONAL SPACE. THE ROWS OF X TIMES THE LENGTHS IN XLAMBDA ARE THE SEMIAXES OF A BOX WHICH CUNTAINS THE POINTS OF A. USED AS SEMIAXES OF AN ELLIPSOID, THE POINTS NOT NEAR THE CORNERS ARE CONTAINED. OTHER CONTAINING BOTTLES CAN BE DEVISED USING X AND XLAMBDA. A IS ROTATED TO COMPONENTS ALONG AXES. ANU IS NP1*NVMAX WORDS LONG. PARAMETER (NPMAX=450,NVMAX=14,ICLMAX=14)
                                                                                                                                                                                                                             & BEING TREATED AS POINTS'

WITH THE STATE OF GRAVITY OF ABOVE CLUSTERS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   C FINDS SET OF ORTHOGONAL VECTORS, THE ROWS OF X SUCH THAT THE ITH C ROW, SAY V, MAXIMIZES A*VTRANSPOSE IN L1 NORM AMONG ALL UNIT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(NPMAX.NE.LNPMAX) WRITE(06,*)' IN BOTTLE NPMAX=',NPMAX,

8. BUT IN NPMAX=',LNPMAX
IF(NVMAX.NE.LNVMAX) WRITE(06,*)' IN BOTTLE NVMAX=',NVMAX,

8. BUT IN NVMAX=',LNVMAX
IF(ICLMAX.NE.LIC.LNNMAX)

1F(ICLMAX.NE.LIC.LNAX)WRITE(06,*)' IN BOTTLE ICLMAX=',ICLMAX,

8. BUT ICLMAX.NE.LICLMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CBOTTLEnnerstangoverspoosbesannangespessonspessons
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DIMENSION A(NPMAX, NVMAX), ANU(NPMAX, NVMAX), X(NAXES, NVMAX),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF(NAXES.ME.LNAXES) WRITE(06,*)' IN BOTTLE NAXES=',NAXES.
8' BUT IN NAXES=',LNAXES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  COMMON LNPMAX, LNVMAX, LICLMAX, LNAXES, LLWK, WK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              SUBROUTINE BOTTLE (A.X.XLAMBDA.NV,NPI)
IF(IMODE.EQ.0)WRITE(06,*)ICASE1
GO TO (9170,9150),ICASE1+1
NP=ICLNAME
                                                                                                                                                                                                                                                                                                                                                                                                                        READ(05,*)ICASE
IF(IMODE.EQ.0)WRITE(06,*)ICASE
WRITE(06,140)
GO TO (9180,130,580), ICASE+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  C FIND BIGGEST ROW OF A IN L2 NORM ITEMP1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (NP1.GT.1) GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         EQUIVALENCE (ANU, WK)
                                                                               DO 9160 1=1, ICLNAME
                                                                                                                                         XINF(1, J)=CG(1, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DIMENSION WK(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   J=1. NVMAX
                                                                                                              UN 1=0 0916 00
                                                                                                                                                                                                                                                                                                               WRITE(06.*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      I HN, I HI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            XLAMBDA(1)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 26 I=1,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   & XLAMBDA(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             35 ANU(1,J)=0.
40 K=K+1
                                                                                                                                                                      WRITE(06, +)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GO TO 150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                00 35
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                                                         9150
                                                                                                                                           9160
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PARAMETER (NPMAX=A50,NVMAX=14,ICLMAX=14)
PARAMETER (NAXES=NVMAX*1CLMAX)
PARAMETER (NVNLAAX=NVMAX*1)/2)
COMMON LNPMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,LNVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NVMAX,NV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(ITEMP2.NE.O.AND.K.LT.NV.AND.K.LT.NP1-1) GO TO 40
                                                                                                                                                                                                                                                                                                                                                                       TEMP1=SQRT(TEMP1)
C STORE IN X WITH LENGTH IN XLAMBDA
DO 70 I=1,NV
70 X(K,I)=A(ITEMP1,I)/TEMP1
XLAMBDA(K)=TEMP1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                SUBROUTINE DETERM(A, N, DETER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   0 TEMP3=0.

DO 100 J=1,NV

0 TEMP3=TEMP3+X(K,J)*A(I,J)

ANU(I,K)=TEMP3

DO 110 J=1,NV

A(I,J)=A(I,J)-TEMP3*X(K,J)

IF(A(I,J).NE.0.) ITEMP2=1

0 CONTINUE
                                                                                                                                                                                                                 9
                                                                          00 50 J=1,NV

) TEMP2=TEMP2+A(I,J)**2

TEMP2=ABS(TEMP2)

IF(TEMP1,GE,TEMP2) GO TO 6/

TEMP1=TEMP2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     A(I,J)=ANU(I,J)
IF(K.GE.NVMAX) GO TO 145
DO 135 J=K+1,NVMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 120 I=1,NP1
IF(I.NE.ITEMP1) GO TO 90
DO 80 J=1,NV
A(I,J)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ANU(I,K)=XLAMBDA(K)
GO TO 120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 60 1=1,N
DETER=DETER*A(I,I)
RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 145 I=1,NP1
DO 130 J=1,K
19N, 1=1 00 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            C MODIFY MATRIX A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                       60 CONTINUE
                                                                                                                                                                                                                                                                                            I TEMP 1 = 1
                                           TEMP2=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DETER=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              125
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  30
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       110
```

TEMP1=0

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SUBROUTINE INSECT(X, ID, K, H, INV, INP, TEMP, ITEMP, IER)

C IN PLACE OF DUAL SOLUTION. IS LISTED THE NON O COMPONENTS OF

C PRIMAL SOLN, THEIR NUMBER, THEIR LOCATION IN PRIMAL SOLN VECTOR.

PARAMETER (NPMAX=450, NVMAX=14, ICLMAX=14)

PARAMETER (NAXES=NVMAX=16, IMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF(NPMAX_EQ_LNPMAX) GO TO 10
WRITE(06.*)' IN INSECT NPMAX=',NPMAX,' BUT IN MAIN NPMAX=',
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DIMENSION X(NPMAX,NVMAX),ID(1),TEMP(1),ITEMP(1),IW(1)
IF(NVMAX,GE,INV+4) GO TO 5
WRITE(06,4)INV,NVMAX-4
FORMAT('INSECT VARIABLES COUNT IS INV=',14,' BUT MAX IS
& NVMAX-4=',14)
                  PARAMETER (ND: AX=450, NVMAX=14, ICLMAX=14)

COMMON LNPMAX, LNVMAX, LICLMAX, LNWK
DIMENSION A(NVMAX, NVMAX), ITEMP(NVMAX)

ET (NVMAX.NE.LNVMAX)WRITE(06,*) IN DTRMIN NVMAX=', NVMAX, B' BUT IN MAIN NVMAX=',LNVMAX

5 ITEMP(K)=0
                                                                                                                                                                                                                                                                                                                   IF(A(K,K).LE.AMAX.OR.ITEMP(K).NE.0) GO TO 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         COMMON LNPMAX, LNVMAX, LICLMAX, LNAXES, LLWK, WK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE(06,*)' 7596',K,AMAX,IMAX,KOUNT,ITEMP &((A(I,J), J=1,M),I=1,N) DO 70 K=1.NVMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(KOUNT.EQ.N.OR.KOUNT.EQ.M) GO TO 60
SUBROUTINE DIRMIN(A,N,M,DETER,KOUNT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF(ITEMP(K).EQ.0) GO TO 70
IF(ISWITCH.EQ.0) DETER=A(K.K)
IF(ISWITCH.NE.0) DETER=DETER*A(K.K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 20 J=1,M
A(I,J)=A(I,J)-A(IMAX,J)*TEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TEMP=A(I, IMAX)/A(IMAX, IMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                        9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF(1.EQ IMAX) GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                                                    IF(AMAX.EQ.U.) GO TO
ITEMP(IMAX)=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    KOUNT=KOUNT+1
                                                                                                                                                                                                                       1-N'1=1 05 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     A(I, IMAX)=0.
                                                                                                                                                                                                                                                                                               N,1=X 01 00
                                                                                                                                                                                                                                                                                                                                            AMAX=A(K.K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 30 I=1,N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       INTEGER H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            50 CONTINUE
60 ISWITCH=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               SWITCH=1
                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              30 CONTINUE
                                                                                                                                                                                          KOUNT=0
                                                                                                                                                                                                                                            AMAX=0.
                                                                                                                                                                                                                                                                        O=XYWI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             RETURN
                                                                                                                                                                                                                                                                                                                                                                      I MAX=K
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CINSECT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    70
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END CDTRMIN---

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TEMP(INV+2)=1.
ITEMP1=ITEMPO+INP+INV
ITEMP1=ITEMPO+INP+INV
ITEMP1=ITEMPO+INP+INV
ITEMP1=LE.ITEMP2) GO TO 200
WRITE(06,*)' IN INSECT NEED TEMP', ITEMP1,' LONG; BUT IS ONLY',
& ITEMP2,' LONG'
LER=135
GO TO 300
200 CALL ZX3LP(TEMP(HINV+6), TEMP(INV+5), N.O.INV+2,
& TEMP(N+INV+5), TEMP(N+INV+6), TEMP(2*N+2*INV+8), TEMP(2*N+1), IER)
IF(IER.EQ.133) GO TO 300
                                   IF(NVMAX.EQ.LNVMAX) GO TO 15
WRITE(OG.*)' IN INSECT NVMAX=',NVMAX,' BUT IN MAIN NVMAX=',
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(M1.GT.INV+2) WRITE(06,*)' ERROR. INSECT HAS MORE THAN'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    &INV+2, 'NON G COMPONENTS'
TEMP(2*N+2*INV+7+M1)=TEMP(N+INV+5+N1)*TEMP1
                                                                                                                                                                                                                                                                                                                                                                                                             50 TEMP(ITEMPO+I+(N-1)+NVMAX)-X(J,I)+TEMP1
TEMP(ITEMPO+IN+1+(N-1)+NVMAX)=TEMP2
TEMP(ITEMPO+IN+2+(N-1)+NVMAX)=TEMP3
TEMP(INV+4+N)--1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF(TEMP(N+INV+5+N1), EQ.U) GO TO 250
                                                                                                                                                 |TEMP0=2+INP+(INV+7)++2-6+INV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ITEMP(2*N+3*INV+10+M1)-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(ID(J),EQ.K) TEMP1=1,
IF(ID(J),EQ.H) TEMP1=-1,
IF(TEMP1,EQ.U) GO TO 250
N1=N1+1
                                                                                                                                                                                      20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ITEMP(2*N+3*INV+10)=M1
                                                                                                                                                                  DO 100 J=1 INP
IF(ID(J).EQ.K) GO TO
IF(ID(J).EQ.H) GO TO
GO TO 100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 250 J=1, INP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 110 I=1, INV
110 TEMP(I)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TEMP(INV+1)=1
                                                                                                                                                                                                                                                                                                                                                                                             DO 50 I=1, INV
                                                                                       1ER=135
G0 T0 300
N=0
IER=135
GO TO 300
                                                                                                                                                                                                                                                                               TEMP3=0.
G0 T0 40
TEMP1=-1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TEMP1=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            250 CONTINUE
                                                                                                                                                                                                                                          TEMP1=1.
                                                                                                                                                                                                                                                               TEMP2=1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        100 CONTINUE
                                                                         & LNVMAX
                                                                                                                                                                                                                                                                                                                                       TEMP2=0
                                                                                                                                                                                                                                                                                                                                                          TEMP3=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 360 RETURN
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FUNCTION LEADOR(x)
C EXAMPLE: LEADOR(.05E20)=19, LEADOR(1.)=1, LEADOR(1.2340E-17)=-16
DO 10 J=1,72
IF(AMOD(x,10.**(36-J))-x)20,10,20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            FUNCTION IDIGIT(1X,1)
C RETURNS IX WITH 0 FOR ALL BUT ITH DIGIT. IDIGIT(9876,3)=800.
DOUBLE PRECISION IDIGIT.Ix.II.I2,ITEN
ITEN+I
I1=ITEN+I
I2=ITEN+(I-1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           SUBROUTINE PLOTSCAT(A, XLAMBDA, NV, NP!)
PARAMETER (NPMAX.456, NVMAX=14, ICLMAX=14)
COMMON LNFMAX.LNVMAX.LICLMAX.LNAXES.LLWK, WK
DIMENS!ON A(NPMAX, NVMAX), XLAMBDA(!), ITEMP(5!), CH(!0)
CHARACTER *1CH, CHR(5!)
                                                                                                                                                                                                                                                                                                                                                                            |DIGIT=DMOD(|X,|)|
|F(I.GT.O)||DIGIT=|DIGIT-CM.S(|X,|12)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FUNCTION LAGO(1)

EXAMPLE: LAGO(850400)=3

DO 10 J=1,11

IF(MOD(1,10**(J-1)).NE.0)GC TO 20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                FUNCTION LEADL(1)
EXAMPLE: LEADG(850400)=7
DO 10 J=1.11
IF(MOD(I,10**(12-J)).NE 1133 TO
                                 IF(X.LT.-60.) EXP0=0.
IF(X.GE.-60.) EXP0=EXP(*)
RETURN
                                                                                                   FUNCTION ALOGU(X)
IF(X)10,20,10
10 ALOGO=ALOG(X)
GO TO 30
20 ALOGO=-60.
GO TO 30
               FUNCTION EXPO(X)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ZU LEADÜR≖37-J
RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         20 LEADO=13-J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       J=J+1
20 LAG0=J-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         10 CONTINUE
                                                                                                                                                                                                           30 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                  RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           RETURN
                                                                                       END
                                                                                                                                                                                                                                    END
CEXPO ---
                                                                                                                                                                                                                                                                                                                                                                                                                                                    CLEADO-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 193
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SUBROUTINE FILELOC(IFILE, LOCOLD, LOCNEW)

C MOVES FILE BROM BEGIN OF RECORD LOCOLD TO BEGIN OF RECORD LOCNEW.

C NOTE THAT AFTER RECORD I HAS BEEN READ, LOCULD WOULD BE I+1.

C STOPS IF READ ERROR

IF(LOCNEW-EQ, LOCOLD) GG TO 50

DU 30 K=1,1ABS(LOCNEW-LGCOLD)

IF(LOCNEW-LOCOLD) 10,30,20

10 BACKSPACE IFILE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                C COMPUTE VECTOR POSITION OF 1. J ENTRY IN NPMAX*NPMAX SYMMETRIC C MATRIX WHOSE UPPER TRIANGULAR PART IS NOT STORED.
C NOTE NPMAX MUST AGREE WITH NPMAX IN MAIN.
DARAMETER (NPMAX=450, NVMAX=14, ICLMAX=14)
11=MAXO(1, J)
J1=MINO(1, J)
IVECTR=(11*(11-1)/2)+J)
IF(11:LE.NPMAX.AND.J1.LE.NPMAX) GO TO 10
WRITE(06.*)' ERROR. IVECTR ARGUMENT EXCEEDS NPMAX'
X=SQRT(-1.)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE(06,50)J, (CHR(1), [=1,51)
FORMAT(16,'',5141)
                                                                                                                                                                                                                                          IF(XLAMBDA(J), EQ.0) GO 70 100
DO 20 I=1,51
ITEMP(I)=0
                                                                                                                                                                                                                                                                                              DO 30 I=1,NP1

I1=26.5+25.*A(I,J)/xLAMECA(J)

I1=MAXO(1,I1)

I1=MINO(51,I1)

ITEMP(I1)=ITEMP(I1)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF(ITEMPO.EQ.0) GO TO AU
                                                                                                                                                                                                                                                                                                                                                                                                                                                       ITEMP0=MINO(10,ITEMP(1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    FUNCTION IVECTR(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CHR(II)=CH(ITEMPD)
CH(2)=:2.
CH(3)=:3.
CH(5)=:4.
CH(5)=:5.
CH(5)=:6.
CH(7)=:7.
CH(9)=:9.
CH(10)=:4.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            SO FORMAT(16, '60 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                        15,1=1 26 00
                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 40 I=1,51
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                        CON1 INUE
                                                                                                                                                                                                                                                                                                                                                                                                                       CHR(1)=.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               10 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CIVECTR
                                                                                                                                                                                                                                                                                 20
                                                                                                                                                                                                                                                                                                                                                                                        30
                                                                                                                                                                                                                                                                                                                                                                                                                       35
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SUBROUTINE DISCRIM(X,ID,K,H,NV,NP,N,P,JER)

DISCRIM SEEKS HYPERPLANE DESCRIBED BY VECTOR P,SCALAR D THAT
SEPARATES PUINTS (ROWS) IN X WHOSE ID IS K FROM THOSE WITH ID H.
THUS FOR POINT Z, Z*P GE D OR LE D AS ID IS K OR H. N IS NUMBER
OF POINTS IN THE TWO SETS, X IS AN NP*NV ARRAY WITHIN AN NPMAX
*NNVMAX ARRAY W IS WORK VECTOR OF LENGTH LB, A LITTLE LT
(NV+2)*N+2*(N+4)**2 IF N GE NV. IER+O IF SUCCESS;
=33,34,70 IF WARNING FROM SV DECOMP OR LP ROUTINES; =129 IF SV
DECOMP FAILS; =130-133 IF LP FAILS; =135 IF DIMENSIONS WRONG.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DIMENSION ID(1), WK(1), P(1)
DIMENSION A(1), V(1), W(1), U(1), Q(1), TEMP(1)
DIMENSION B(1), C(1), PSOL(1), DSOL(1), RW(1), IW(1)
EQUIVALENCE (A(1), WK(1)), (V(1), WK(1)), (W(1), WK(1)),
&. (U(1), WK(1)), (Q(1), WK(1)), (TEMP(1), WK(1)), (B(1), WK(1)),
&. (KW(1), WK(1)), (PSOL(1), WK(1)), (DSOL(1), WK(1)), (IW(1)), WK(1)),
M=MAXO(N, NV+1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CDISCRIMентальный политический приментический приментальный приментальный приментальный приментальный приментал
                                            GO TO 50
40 WRITE(06,*) FRROR IN FILELOC WHILE READING FILE ', IFILE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         COMMON LNPMAX, LNVMAX, LICLMAX, LNAXES, LLWK, WK
INTEGER H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PARAMETER (NPMAX=450,NVMAX=14,ICLMAX=14)
PARAMETER (NAXES=NVMAX*ICLMAX)
READ(IFILE, ERR=40, END=40) (TEMP, L=1, 10)
                                                                                                                                                                                                                                                                                                                                                    W(7)=A(I+IA*(K-1))*A(7+IA*(K-1))+M(7)
                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 70 I=2,N
DO 70 J=1,I-1
A(I+IA*(J-1))=A(J+IA*(I-1))
                                                                                                                                                                                                                                       DIMENSION A(1), W(1)
DO 60 I=1, N
DO 40 J=1, N
                                                                                                                                                                                                                                                                                                                                                                                                                     a(i+ia+(j-1))=w(j)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           LZ=L1+(N+3)+N
                                                                                                                                                                                                                                                                                                        W(J)=0.
D0 30 K=1.M
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LO=M*(NV+1)
                                                                                                                                                                                                                                                                                                                                                                                                 N. 1=L 02 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      & MAXO(N.NV)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        TO 600
  20 READ(IFI)
30 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            L4=L3+N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               1ER=135
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     L.1=L0+1
                                                                                                             50 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RETURN
                                                                                         STOP
                                                                                                                                     ENO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         70
                                                                                                                                                                                                                                                                                                                                                  30
                                                                                                                                                                                                                                                                                                                                                                                                                   20
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IF(L.LE.N) GO TO 45
WRITE(06.*)' DISCRIM COUNT EXCEEDS',N,' POINTS WITH ID',K,' OR'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          GET SINGULAR VALUE DECOMP OF N*(NV*1) MATRIX A AS U*Q*VTRANSPOSE WHERE U IS N*N (BUT IMBEDDED IN AN (N+3)*N ARRAY). Q IS N*(NV*1), V IS (NV*1)**2. ONLY THE NV*1 DIAGONAL WORDS OF Q ARE STORED. V STORED OVER A. U INITIALIZED TO IDENT. UTRANSPOSE STORED OVER U.
                                                                         iŧ
                                                                                                                                 GO TO GOO
10 IF(NVMAX.EQ.LNVMAX) GO TC 15
WRITE(06,*)' IN DISCRIM NVMAX=',NVMAX,' BUT IN MAIN NVMAX='
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL LSVDF(A,M,N,NV+1,U(L1+1),N+3,N,Q(L2+1),TEMP(L2+NV+2),
TOL=_00)
IF(NPMAX.EQ.LNPMAX) GO TO 10
WRITE(06.*)' IN DISCRIM NPMAX=',NPMAX,' BUT IN MAIN NPMAX
8.LNPMAX
                                                                                                                                                                                                                                                     GO TO 600
C PUT THE N POINTS OF X WITH ID K OR H INTO N*(NV+1) MATRIX A.
C IN COL NV+1 ENTER -1 IF POINT HAS ID=H, +1 IF POINT HAS ID=H.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        L REPLACE V BY W=VDQTUT, AN (NV+1)*N MATRIX. T=TRANSPOSE. D IS C (NV+1)**2 GENERALIZED INVERSE OF QTQ.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              8 JER)
IF(IER.EQ.33.OR.JER.EQ.34)WRITE(06,*) WARNING: LSVDF
8 DISCRIM RETURNS IER=', IER
IF(IER.EQ.129) GO TO 600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF(ABS(Q(L2+I)).GT.QMAX)QMAX=ABS(Q(L2+I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(ABS(Q(L2+1)), LT. TOL *QMAX)Q(L2+1)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             GO TO 600
45 DO 50 J=1,NV
50 A(L+(J-1)*M)=TEMP1*WK(L4+J)
A(L+NV*M)=TEMP2
                                                                                                                                                                                                                                                                                                                                                                   READ(22)(WK(L4+J),J=1,NV)
IF(ID(I),EQ.K) GO TO 20
IF(ID(I),EQ.H) GO TO 30
GO TO 80
20 TEMP1=+1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 110 J=1,N
110 U(L1+I+(J-1)*(N+3))=0.
120 U(L1+I+(I-1)*(N+3))=1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          (U 145 1-1, N+Nv+(NV+1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 130 I=1,NV+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 140 I=1,NV+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 120 I=1,N
                                                                                                                                                                                                                                                                                                                                             ON 1=1 08 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TEMP2=+1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          GO TO 40
30 TEMP1=-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     140 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       TEMP2=-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       80 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              130 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IER=136
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             40 L=L+1
                                                                                                                                                                                                                                                                                                                       15 1-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 00000
```

CONTINUE

C SOLVES AX=B WITH X GE O. USING NON OBJECTIVE SIMPLEX METHOD. X IS C NON UNIQUE & IS RETURNED IN PLACE OF B. A IS M\*N MATRIX, WITH ROW C DIMENSION IA ASSUMES THAT A CONTAINS. L.U. FACTORS AS PRODUCED BY L. LUFACTR, BACKS, WITH UTHER ORIGINAL COLUMNS Q REPLACED BY UINV\*Q B HAS M CUMPUNENTS. X HAS N COMPONENTS, BUT ONLY M ARE C NON O. IN OUTPUT, COMPONENT A(IR(K)) MULTIPLIES COLUMN JC(K); 150 CONTINUE
160 CONTINUE
160 CONTINUE
150 C WRITE(06,\*)' IN DISCRIM, WK REQUIRES L8=',L8,' WORDS BUT HAS D0 160 1=1,NV+1 D0 150 J=1,NV+1 D0 150 L=1,NV+1) =0. IF(Q(L2+L),EQ.0,) G0 T0 150 W(I+(J-1)\*(NV+1))=W(I+(J-1)\*(NV+1))+RW(L3+I+(L-1)\*(NV+1))\* &U(L1+L+(J-1)\*(N+3))/Q(L2+L) DO 170 J=1,N U(L1+1CONSTR+(J-1)+(N+3))=U(L1+I+(J-1)+(N+3)) IF(I.LE.NV+1.AND.Q(L2+I).NE.O.) GO TO 180
ICONSTR=ICONSTR+1 CNOSMPL Хавараравининининининининининининини P(I)=P(I)+W(I+(J-1)\*(NV+1))\*PSOL(L4+J)D=D+W(NV+1+(J-1)+(NV+1))+PSOL(L4+J) RW(L3+I+((I-1)/M)\*(NV+1-M))=V(I)8 AVAILABLE ONLY LLWK=', LLWK GO TO 600 B(L2+1)=1. D0 175 1=2,ICONSTR+1 175 B(L2+1)=0. D0 210 I=1,N 210 C(L3+1)=1. L5=L4+MAXO(N,ICONSTR+1) LB=L7+(ICONSTR+4)\*\*2 IF(LLWK.GE.L8) GO TO 190 DO 165 J=1,N 165 U(LO+1+(J-1)\*(N+3))=1. ICONSTR=0 L7=L6+2\*1CONSTR+7 L6=L5+IC0N3TR+3 DO 230 I=1,NV P(I)=0. D0 230 J=1,N N, 1=1 081 00 DO 240 J=1,N REWIND 22 CONTINUE 240 145

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OMITTED COMPONENTS =U. IFEAS=-NUMBER NEG COMPONENTS OF X; IFEAS=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 THETAL(KOUNIL)=0.

IF(ABS(X(IR(I))).LE.ABS(A(IR(I)+(K-1)*IA))*XINTES) GO TO 125

IF(ABS(X(IR(I))).LE.ABS(A(IR(I)+(K-1)*IA))

THETAL(KOUNIL.EQ.2) GC TO 127

IF(THLMAX.GE THETAL(KOUNIL)) GO TO 130

127 THLMAX=THETAL(KOUNIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      C
C SEARCH FOR REPLACEMENT COL FOR BASIS, WHICH WILL DECREASE NKOUNT
C OMITTED COMPONENTS = 0. a.c....
C IF LP PROBLEM IS . = 4SIBLE.
PARAMETER (NPMAX=450, NVMAX=14, ICLMAX=14)
PARAMETER (NVMAX+1)
PARAMETER (NVMAX+1)
DIMENSION A(1), IR(1), JC(1), IR(1), JC(1), X(1)
B, THETAU(NVMAX), THETAL(NVMAX+1)
COMMON LNPMAX, LNVMAX, LICLMAX, LNVMAX, X
IF(NVMAXNE, LNVMAX) WRITE(06,*)' IN NOSMPLX NVMAX; NVMAX, X
B, BUT IN MAIN NVMAX= 'LNVMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF(JCI(K).NE.0) GO TO 200
COLUMN K OF A. DETERMINE UPPER, LOWER BOUNDS ON THETA
KOUNTU=0
                                                                                                                                                                                           # UC: IN MAIN NVMAX=', LNVMAX

XINFEN=1000.

XINFEN=1000.

XINFEN=1000.

XINFEN=1000.

XINFEN=1000.

CALC B B U UNV*LINV*B

CALC B B U UNV*LINV*B

CALC BACKS! (A,1A,M,N,IR,JC!,IRANK,X)

C REPLACE L,U IN A BY IDENTITY MATRIX

DO 20 J=1,IRANK

DO 30 J=1,IRANK

30 A(IR(T)*(JC(J)*1)*IA)=1.

NKOUNT=0

DO 50 I=1,IRANK

IF(X(1)*(JC(N)*1)*IA)=1.

SO CONTINUE

CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   KU=0

KL=0

DO 130 I=1,IRANK

IF(ABS(A(IR(1)+(K-1)*IA)).LE.XINTES) GO TO 130

IF(A[IR(I)+(K-1)*IA)) 120,130,110

KOUNTU=KOUNTU+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          THETAU(KOUNTU) = X(IR(I) / A(IR(I) + (K-1) * IA)
IF(KOUNTU.EQ.1) GO TO 115
IF(THUMIN.LE.THETAU(KOUNTU)) GO TO 130
IHUMIN=THETAU(KOUNTU)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(NKOUNI.EQ.U) GO TO 290
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  KOUNTL=KOUNTL+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ITHDIFR=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 200 K=1,N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 THETAL(1)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      GO TO 130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           KOUNTL=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IUR=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  KUR=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          KLR=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         10=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               11=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    115
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             C FOR
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IF(KOUNTU.NE.O) THDIF=THUMIN-THLMAX
DETERMINE FOR EACH COLUMN IN BASIS, THE NUMBER KOUNTC OF NEGATIVE
COMPONENTS IN X IF THAT COL IS REPLACED IN BASIS BY COL K OF A
DO 195 I=1,IRANK
                                                                                                                                                                                                                                                                                                  IF(ABS(X(IR(1))).LE.ABS(A(IR(1)+(K-1)*IA))*XINTES) GO TO 155
TEMP=X(IR(1))/A(IR(1)+(K-1)*IA)
155 IF(KOUNTL.EQ.0) GO TO 170
DO 160 K1=1, KOUNTL
IF(TEMP.GE.THETAL(K1)) GO TO 160
NKOUNTC=NKOUNTC+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        REPLACEMENT OF COL IR(IREM) IN BASIS BY COL KREM, WILL REDUCE NUMBER OF NEGATIVE COMPONENTS IN X FROM NKOUNT TO MKOUNTR
IF(INKOUNTR-NKOUNT) 210,205,209
205 IF(ITHDIFR-EQ.1) GO TO 209
IF(ITHDIFR-EQ.1) GO TO 209
IF(INE.EQ.0.AND.ML.EQ.0) GO TO 209
IF(INE.EQ.0.AND.ML.EQ.0) GO TO 209
IREM=1UR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   C IF NO REPLACEMENT WILL REDUCE NKOUNT, TRY TO INCREASE THDIF.

IF (NKOUNTR.EQ.U) GO TO 210

IF (NKOUNTR.NE.NKOUNT) GO TO 200

IF (INCOUNTR.EQ.L) GO TO 200

IF (ITHDIFR.EQ.L) GO TO 199

IF (ITHDIF.LE.THDIFR) GO TO 200

IF (THDIF.LE.THDIFR) GO TO 200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           180 CONTINUE
190 IF(I.EQ.IU.AND.KU.EQ.K.AND.NKOUNTC.GT.NKOUNT) IU=0
IF(I.EQ.IL.AND.KL.EQ.K.AND.NKOUNTC.GT.NKOUNT) IL=0
IF(INKOUNTR.LE.NKOUNTC) GO TO 195
NKOUNTR=NKOUNTC
                                                                                                                                                                                 IF(A(IR(I)+(K-1)*1A)) 150,140,150
IF(X(IR(I)).GE.O.) GO TO 195
NKOUNTC=NKOUNTC+1
GO TO 195
TEMP=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                 160 CONTINUE
170 IF(KOUNTU.EQ.0) GO TO 190
DO 180 KI=1,KOUNTU
IF(TEMP.LE.THETAU(K1)) GO TO 180
NKOUNTC=NKOUNTC+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF(IUR.NE.0) GO TO 215
IREM=ILR
                                                                                                                                                                   NKOUNTC=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ITHDIFR=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             GO TO 215
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 200 CONTINUE
                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    195 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       KREM=KLR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IUR=10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        KUR=KU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    KRENIK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    1LR=1L
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            KLR=KL
1-11
                                        130
                                                                                                                                                                                                                  140
                                                                                                                                                                                                                                                                               150
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THE SERVICE SERVICES OF SERVICES OF SERVICES OF SERVICES

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CTRIANGULAR FACTORS L,U ARE GOTTEN FOR SQUARE SUBMATRIX OF THE M*N C MATRIX A, WITH USE OF PIVOTING. THE KTH CHOSEN ROW.COL IN L+U-I IS IN LOCATION IR(K), JC(K) OF A. THE DIAGONAL OF L IS I AND NOT C STORED. THE RANK OF A IS IRANK. REQUIRES M LE N. ANY COLUMN Q OF A C NOT USED IN L,U HAS BEEN PROCESSED THE SAME AS THE LAST COL OF U, C IN USED IN L,U HAS BEEN PROCESSED THE SAME AS THE LAST COL OF U, C IN SECOME LINV*Q. IA IS THE ROW DIMENSION OF A, IRI, JCI ARE THE C INVERSES OF IR,UC IN SENSE IRI(ROW K) = ORDER IN WHICH ROW K C INTRODUCED INTO BASIS; IS O IF NOT USED. DITTO FOR JC(COL K). THUS IR(TIME K) = LOCATION H; IRI(LOCATION H) = TIME K
                                                                                                                                                IF(ABS(X(IR(IREM))).LE.ABS(A(IR(IREM)+(KREM-1)*IA))*XINTES)
                                                                                                                                                                                                                                                                                                                                                                                                                                                  X(IR(IREM))=THETA

DO 260 J=1.N

IF(J.EQ.KREM) GO TO 260

DO 250 I=1.IRAM) GO TO 250

A(IR(I)+(J-1)*IA)=A(IR(I)+(J-1)*IA)-A(IR(IREM)+(J-1)*IA)*

&A(IR(I)+(KREM-!)*IA)/A(IR(IREM)+(KREM-I)*IA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            A(IR(IREM)+(J-1)+IA)=A(IR(IREM)+(J-1)+IA)/A(IR(IREM)+
                                                                                                                                                                        & GO TO 220
THETA=X(IR(IREM))/A(IR(IREM)+(KREM-1)*IA)
220 JJ=JC(IREM)
                                                                                                                                                                                                                                                                         JCI(JJ)=0
JCI(KREM)=IREM
DO 240 I=1,IRANK
TEMP=A(IJ+(KREM-1)*IA)
IF(ABS(TEMP).LE.XINTES) GO TO 240
X(IR(I))=(X(IR(I))/TEMP-THETA)*TEMP
                                             C UPDATE IR, JC, IRI, JCI, A, X, NhOUNT 210 NKOUNT=NKOUNTR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 270 I=1,IRANK
270 A(IR(I)+(KREM-1)*IA)=0.
A(IR(IREM)+(KREM-1)*IA)=1.
C TERMINATION PROCEDURE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           1F(NKOUNT.GT.0) GO TO 100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF(IRI(1).NE.0) GO TO 50
                                                                                                                                                                                                                                                      JC (IREM) = KREM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        & (KREM-1)*IA)
209 IFEAS=-NhOUNT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                JC1(J)=U
DO 100 K=1,M
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  M, 1=1 0t 00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 20 J=1,N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELMAX=0.
DO 50 [=1.M
                                                                                                 ITHDIFR= 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IR(1)=0
IRI(1)=0
                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      250 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  260 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IRANK=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                10 10(1)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        300 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CLUFACTR-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             20
                                                                                                                                                                                                                                                                                                                                                                                                                                 240
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50 CONTINUE
60 DO 70 J=1,N
IF(JCI(J).NE.0) GO TO 70
A(IR(II1)+(J-1)+IA)=A(IR(II1)+(J-1)+IA)/A(IR(II1)+(JC(II1))-1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SUBBOUTINE BACKSI(A.IA.M.N.IR.JC.IRI.JCI.IRANK.X)
C COMPUTES UINV*LINV*X AND STORES IN X. X HAS M COMPONENTS. A IS
C NO! CHANGED. ASSUMES L.U ARE IN A IN FORM PRODUCED BY LUFACIR.
C ESSENTIALLY PERFORMS ON SEPARATE VECTOR X, WHAT BACKS DOES TO COL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SUBROUTINE BACKS(A, IA, M, N, IR, JC, IRI, JCI, IRANK)

C ASSUMES A HAS BEEN PROCESSED BY LUFACTR. COLUMN Q OF A, NOT IN L.U WAS REPLACED BY LUFACTR. HERE THIS IS REPLACED BY LINV*UINV*Q. THE L.U MATRICES ARE NOT ALTERED.

UIMENSION A(1), IR(1), JC(1), IRI(1), JCI(1)

DO BO II=1, IRANK

III=IRANK+1-II

IF(III-EQ.IRANK) GO TO 60

DO SO I=III+1 IRANK

TEMP=A(IR(III)+(JC(I)-1)*IA)

DO 40 J=1, N

IF(JCI(J).NE.O) GO TO 40

AIR(II)+(J-1)*IA)=A(IR(III)+(J-1)*IA)+(J-1)*IA)+(J-1)*IA)
                                                                                                                                                                                                                                                                                                                                          IF(JCI(J).NE.O) GO TO BO
CALT.(J-1)*IA)=A(I+(J-1)*IA)*A(I+(JJ-1)*IA)
CONTINUE
CONTINUE
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             40
                                                                                                                                                                                                                                                                            DG 90 I=1,M

IF(IRI(I).NE.0) GO TO 90

A(I+(JJ-1)*IA)=A(I+(JJ-1)*IA)/ELMAX

DQ 90 J=1,N
DO 40 J=1,N

IF(JCI(J) NE.J) GO TO 40

TEMP=A(1+(J-1)*1A)

IF(ABS(ELMAX).GE.ABS(TEMP)) GO TO

ELMAX=TEMP
                                                                                                                                                                     IF(ELMAX.EQ.0) GO TO 300
                                                                                                                                                                                   IRI(II)=K
JCI(JJ)=K
IR(K)=II
JC(K)=JJ
IRANK=IRANK+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                40 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             70 CONTINUE
80 CONTINUE
                                                                                                                                40 CONTINUE
50 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                     300 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             & TEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ( ¥ 1 ¥ )
                                                                                                                111
                                                                                             1 = 1 I
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CBACKSI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CBACKS-
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SUBROUTINE VERTEX (X,N,M,NMAX,1D,1DMAX,TEMP,1TEMP)
C GIVEN N+M TABLE X OF N POINTS HAVING M COMPONENTS WITH ROW DIMEN-
C SION NMAX, AND VECTOR ID OF IDENTIFICATION NUMBERS 1 THRU IDMAX
C FOR THE N PTS OF X, FINDS THE 2M PTS WITH MAX OR MIN COMPONENT
C FOR EACH SET OF PTS WITH SAME ID. 1ST IDMAX ROWS OF TEMPM HAVE PT
C NUMBERS, 1ST M WORDS ARE FOR MAX, 2ND M FOR MIN, 4+MMAX WORDS PER
C ROW, NEXT IDMAX ROWS FOR CORRESPONDING COMPONENT VALUES.
C TEMP/ITEMP IS AN ARRAY OF SIZE (2*IDMAX)
DIMENSION X(1),ID(1),TEMP(1),ITEMP(1),NID(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ITEMP0=0
GO TO 20
ENTRY VERTX (X,N,M,NMAX,NMAX,NID,IDMAX,TEMP,ITEMP)
C VERTX ASSUMES POINTS WITH SAME ID ARE GROUPED TOGETHER IN X, NID
C IS A VECTOR OF LENGTH IDMAX HAVING IN NID(I) THE NO. OF PTS IN
C ITH GROUP.
                                                                                                                                                                                                                                                                                                                              DO 180 II=1.IRANK
III=IRANK+1-II
IF(II).EQ.IRANK) GO TO 160
DO 150 I=II1+1.IRANK
X(IR(II))=X(IR(II))-X(IR(I))*A(IR(II)+(JC(I)-1)*IA)
X(IR(II))=X(IR(II))/A(IR(II))+(JC(II)-1)*IA)
                                           50 x(IR(II))=x(IR(II))-x(IR(I))+A(IR(II)+(JC(I)-1)+IA)
80 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              XIJ=X(II+(J-1)*NMAX)
IF(ITEMP(II).EQ.0) GO TO 50
IF(ITEMP(II+M).EQ.0) GO TO 80
IF(ITEMP(IM).EQ.0) GO TO 100
40 IF(XIJ-TEMP(II+L)) 60,42.50
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 10 NI=1,IDMAX
ITEMPO=ITEMPO+NID(NI)
IF(ITEMPO.NE.0) GO TO 20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF(I.LE.ITEMPU)IDI=N1
IF(I.LE.ITEMPU) GO TO 38
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF(ITEMPO.GT.N) STOP 12
G0 T0 300
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 30 I=1, IDMAX
DO 30 J=1, 2*M
ITEMP(J+(I-1)*4*MMAX)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF(NI.GT.IDMAX) STOP 13
ITEMP0=ITEMP0+NID(NI)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(ITEMPO.NE.O) GO TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IM=2+M+(IDI-1)+4+MMAA
1F(11.EQ.1) GO TO BO
DO 50 1=1,11-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            II=J+(IDI-1)+4+MMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      L=4*MMAX*IDMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 200 I=1,N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       100 J=1,M
                                                                                           CALCULATE UINV+Y
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   (1)01=101
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ITEMP0=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                GO TO 38
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     [+[N=]N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           INHIOI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          []=[
                                                                                                                                                                                                                                                                                                                           CVERTEX===
                                                                                                                                                                                                          150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               38
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ں
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```
EPS IS USED IN TESTS FOR ZERO
IF ABS(T) .LE. EPS, THEN T IS
CONSIDERED TO BE ZERO
ZERO/0.0/, ONE/1.0/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       MAKE SURE STARTING SOLN. IS POS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ENTRY 2X2LP (C.D.ICOLMS.ROW.K.M.N.ITMAX.LIC.IR.COPI.IDES.X. & WA.IER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         MAKE SURE RHS IS NON-NEGATIVE
                                                                                                                                                                                                                                                                                                                                                                                      C(IR,1),COPI(IR,1),D(1),X(1),WA(1)
ICOLMS(1),IDES(1),ROW(1)
C,D,ROW,COPI,X,WA,R1,R2,R3,D1,ZERO,ÖNE,
                                                                                                                                                                                                                                                                                                                               SUBROUTINE ZXILP (C.D.ICOLMS, ROW, K, M, N. ITMAX, LIC, IR, COPI
                                                                  IF(II) 200,200,100
60 IF(XIJ-TEMP(II+M+L)) 70,62,100
62 GO TO 100
70 IO=ITEMP(II+M)
                                                                                                                                                                 EPS/1.0E-5/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                MP1 = M+1

RMT = MP1*5û

DO 10 I=1SW.MP1

IF (D(1).GE.ZERO) GO FO 10

IER = 129
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                00 20 1=; MP1

01 = ZERU

02 = ZERU

00 15 J=1,MP1

1 = COP1,(1,J)+D(J)

01 = D1+T
                                                                                                                          ITEMP(II+M)=I1
TEMP(II+M+L)=XIJ
                                                                                                                                                                                                                                                                                                                                                                                                                   REAL
& EPS.DZ.D3.T.RMT
DATA
            IO=ITEMP(II)
ITEMP(II)=I1
TEMP(II+L)=XIJ
                                                                                                                                                                                                                                                                                                                                                           8. IDES, X, WA, IER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       GO TO 9000
10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                      UIMENSION
DIMENSION
                                                                                                                                                                                                                                                                    100 CONTINUE
200 CONTINUE
300 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ITER = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      15W = 3
G0 T0 5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     S IER = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ISW = 2
                                                                                                                                                        1=10
                                                         11=10
                                                                                                                                                                                                                                                                                                                  END
50
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```
FIND NEXT PIVOT COLUMN (1Q)
                                                                                                                                                                                                                                                                                                                                                                                                                                                       FIND NEXT PIVOT ROW (IP)
                                    (D2+ABS(D1) .EQ. D2) D1 = ZERO
(I.LT.ISW) G0 T0 20
                                                                                                                                                                                                                                                                                                                                                                                         (D2+ABS(D1), EQ. D2) GO TO 40
(D1,GE.R1) GO TO 40
= D3
                                                                                                                                                                                                                                    GO TU 35
                                                                   D1 = COPI(1,J)

IF (II.LT.0) D1 = -D1

IF (J.EQ.K) D1 = ZERO

D2 = ONE

IF (J.EQ.K) D2 = ZERO

D1 = D1+COPI(1,K)*ROW(L)

D2 = D2+ABS(ROW(L))

D2 = D2+D3*RMI
                                              IF (1.LT.ISW) GO 10 20
IF (D1.LT.-EPS) IER = 130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          00 45 J=1,MP1

D1 = D1+COPI(I,J)*D(J)

D3 = D3+ABS(COPI(I,J))

CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      X(I) = UI
IF (10.GT.N) GO TO 55
IF (10.EQ.U) GO TO 65
DI = ZERO
D2 = D2+ABS(T)
                                                                                                                                                                                                                                                                       35 CONTINUE
DO 40 L=1 LIC
II = ICOLMS(L)
                                                                                                                                                                                                                                                                                                       J = IABS(II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  65 I=1,MP1
D1 = ZERO
D3 = ZERO
D0 45 J=1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                               R1 = -ONE
IP = 0
D0 65 I=1,
                                                                                                                                                                                                                                                                                                                                                                                                                                  40 CONTINUE
R3 = R1
                                                                  20 CONTINUE
          5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              45
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PSOL(IDES(I)) = X(I)-TH+WA(I)
PSOL(IQ) = TH FOR TH .GT. 0.0
THE OBJECTIVE FUNC TENDS TO
INFINTY AS TH TENDS TO INFINTY
                                                                                                                                                                                                                                                                                                                                                                                                                                       DECIDE IF PRESENT SOLN OPTIMAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       INCREASE IN OBJECTIVE FUNC 1S
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              UNBOUNDED FEASIBLE SOLUTION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ITER = ITER+1
IF(MOD(ITER,100).EQ.U)WRITE(06,*)' ZX1LP HAS DONE',ITER,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       FORM E(1P, 1Q) + COP1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
DO 90 1=1,MP1
IF (I.Eq.IP) GO TO 90
D1 = WA(I)
D0 B5 J=1,MP1
COPI(I,J) = COPI(II,J)+D1
                                                                                                                                                                                                                                                                                               (D2+4BS(D1) .EQ. D2) GO TO 65
(D1.LE.EPS) GO TO 65
(I.LT.ISW) GO TO 65
= X(I)/D1
(R2.GE.R1.AND.R1.GE.ZERO) GO TO 65
                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (IQ.EQ.0) GO TO 9005
DO 70 J=1,MP1
IF (IDES(J).EQ.IQ) GO TO 9005
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 01 = WA(IP)

D0 80 J=1,MP1

COPI(IP,J) = LOPI(IP,J)/61
                                                                                                                                                                                                                                                                                                                                                                                      IF (RI.LT.ZERO) RI = ZERO
IP = I
                                                                                                                                                                                                       IF (J.EQ.K) D2 = ZERO
D1 = D1+COPI(I,K)*ROW(IN)
D2 = D2+ABS(ROW(IN))
D2 = D2*D3
D2 = ZERO
D0 50 J=1,MP1
T = COPI(I,J)+C(J,IG)
D1 = D1+T
D2 = D2+ABS(T)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (ITER.GE.ITMAX) GO TO 95
IF (IP.NE.O) GO TO 75
                                                                                                 IN = 1Q-N

II = ICOLMS(IN)

J = IABS(II)

D1 = CODI(I.J)

IF (II.LT.0) D1 = -D1

IF (J.EQ.K) D1 = ZERO

D2 = ONE
                                                                                                                                                                                                              1,

01 = 02 = 0.

02 = 02.0.

WA(I) = 01

>2 = 02.8MT

'02+ABS!'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      10Es(1P) = 1Q
                                                                          CONTINUE
                                                                                         GO TO 60
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GO TO 9000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IER = 131
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                70 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                        65 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         BS CONTINUE
                                                                        20
                                                                                                   55
                                                                                                                                                                                                                                                                     9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 80
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SUBROUTINE ZX3LP (A,1A,B,C,N,M1,M2,S,PSOL,DSOL,RW,IW,IER)

C IER=130 MEANS IA× M1 + M2 +2

C 131 COST CRITERION UNBOUNDED

C 132 MAX NUMBER OF ITERATIONS

C 133 NO FEASIBLE SOLUTION EXISTS

C 70 SOME ARTIFICIAL VARIABLES REMAINED IN SOLN BASIS AT

C 70 LEVEL AFTER PHASE 1 - MAYBE DUE TO REDUNDANT CON-

STRAINTS. SOLN RETURNED IN PSOL & DSOL.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TERMINAL ERROR - IA IS LESS THAN MI+M2+2
                                                                                                                                                                                                                                                                        A(IA,1), B(I), C(I), PSOL(I), DSOL(I), RW(I), IW(I)
A,B,C,PSOL, DSOL, RW, ZERO, TEMP, ONE, S, EPS
EPS/I, 0E-5/
                                                                                                                                                                                                                                                                               EPS IS USED IN TESTS FOR ZERO
IF ABS(T) .LE. EPS, THEN T IS
CONSIDERED TO BE ZERO
ITMAX/2000/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CHECK EQUALITY CONSTRAINTS FOR NEGATIVE RIGHT HAND SIDE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         MOVE A AND B DOWN 2 ROWS
& ITERATIONS OF ALLOWED , ITMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        1F (B(I).GE.ZERO) GO TO
B(I) = -B(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PSOL(1-2) = -PSOL(1-2)

DO 20 J=1,N

A(1,J) = -A(1,J)

CONTINUE
                                                             CALL UERTST (TER, 'ZXTLP' 9005 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ß
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (IA.GE.M12+2) GO TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (M2.EQ.0) GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      B(IK) = B(K)
PSOL(1) = I
DO 10 J 1,R
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 15 I-1 IEND
H IENDI I
IR - H+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 25 I=IBEG, IR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IEND: - IEND-1
                                                                                                                                                                                                                                                                                                                                                                                                                                      IEND = MI+M2
M12 = IEND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        MIP2 = M1+1
MIP2 = M1+2
MIP3 = M1+3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IR = IEND+2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        18EG = M1+3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IER = 130
GO TO 9000
                  GO TO 25
95 IER = 132
                                                                                                                                                                                                                                                                           DIMENSION
                                                9000 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        L ton . ENUE
                                                                                                                                                                                                                                                                                                                                                                                                          IER
                                                                                                                                                                                                                                                                                                                                                                                                                          JER
                                                                                                              CZX3LP-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         5 5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        97
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0
           RE-URDER OTHER CONSTRAINTS SUB(1) GE. 0 I = 1,...M1-IQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                        COMPUTE ROW 1 AND 2 OF A AND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        GET ICOLMS AND ROW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PACK A
                                                                                                                                                                                                                                                                                            0 CONTINUE

10 = 10+1

PSOL(INEXT-2) = -PS()L(INEXT-2)

B(INEXT) = -B(INEXT)

DO 50 J=1,N

A(INEXT,J) = -A(INEXT,J)
                                                                                 IEMD = MIP2
INEXT - IEMD
INEXT - IEMD
IF (INEXT - EQ. IEMD) GO TO 45
IF (INEXT - EQ. IEMD) GO TO 45
IEMP = B(IEMD) GO TO 45
B(IEMD) = B(INEXT)
B(INEXT) = TEMP
TEMP = PSOL(IEMD-2)
PSOL(IEMD-2) = PSOL(INEXT-2)
PSOL(INEXT-2) = TEMP
DO 40 J=1.N
A(IEMD,J) = A(INEXT,J)
A(IEMD,J) = A(INEXT,J)
A(INEXT,J) = TEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    MIMIQ - M1 IQ

L1 = M1P1-1Q

D0 95 I=1,LIC

IF (I.GE.M1P3) G0 T0 90

IF (I.GE.M1P3) G0 T0 85

RW(I) = -0NE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   A(2,3) = -C(3)
A(1,3) - ZERG
BO 65 1=2.1R
A(1,3) = A(1,3)-A(1,3)
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 75 J=1, N

DO 75 I=1, IR

K = MUCIN, [A.T]

IF (K.EQ.1) L = LT1

A(K.L) = A(I,J)

75 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (IEND.NE.2) GO TO 35
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (IA, EQ, IR) 30 TO 80
                                          30 10 = 0
IF (M1.EQ.0) GO TO 60
IEND = M1P2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  B(1) = B(1) - B(1)
                                                                                                                                                                                                                                                                                                                                                                                                          INEXT = INEXT: 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 B(1) = ZERU
B(2) - ZERU
DO 70 I=3,IR
                                                                                                                                                                                                                                                                                                                                                                                                                     55 IEND = IEND-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        60 00 65 J=1,N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        80 LIC = IR+1Q
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 M = M12+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               70 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                        50 CONTINUE
25 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              35
                                                                                                                                                                                                                                                                                             404
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   65
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SOLVE PHASE I PROBLEM
4DSOL, RW(IWK), IER)
IF (IER.NE.O) GO TO 185
K = MIP2+N
J = 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ARTIFICIAL VARIABLES REMAIN IN THE SOLUTION AT A ZERO LEVEL
                                                                                                 RK STORAGE ASSIGNMENTS

ICOLMS(1) = IW(1)

IDES(1) = IW(1DES)

COPI(1,1) = RW(ICOPI)

ROW(1) = RW(1)

WA(1) = RW(IWK)

X(1) = DSOL(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CHECK PHASE 1 SOLUTION FOR ARTIFICIAL VARIABLES
                                                                                                                                                                                                        GET IDES
                                                                                                                                                                                                                                                                                                                                                             GET COPI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Dú 125 1±IDES2,1ENDIW
IF (IW(I),LE.K) GO TO 120
IF (USÚL(J),úI.EPS) GO TO 180
                                                                                                                                                                                                                                                                                           DO 100 I=1DE52,1ENDIW

IW(I) = K

IF (I.EQ.IEND) K = N+M1P2

K = K+1

100 CONTINUE
                                                                                                                                                                                                                IDES = LIC+1
IW(IDES) = N+M1P2
IDES2 = IDES+1
IEND = IDES2+M1M1Q
IENDIW = IDES2+M12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 115 I=ICOPI.K,IR
RW(I+J) = ONE
J = J+1
115 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                       ICOPI = IDES
IWK = IR*IR+ICOPI
K = IWK-1
IW(1) = [++]
GO TO 95
RW(1) = ONE
IW(1) = -1-+
GO TO 95
RW(1) = ZERU
IW(1) = 1-1Q
                                                                                                                                                                                                                                                                                                                                                                                                          DO 105 I=ICOPI, K
RW(I) = ZEP?)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      RW(L) = ONE
                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
L = ICOPI
J = MIMIQ+1
DO 110 I=1, J
                                                                                                                                                                                          IW(M1P2) = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          L = L+IR
                                                                                       95 CONTINUE
                                                                                                                                                                                                                                                                                 K = N+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 0 = 7
                                                                                                                                                                                                                                                                                                                                                                                                                                       105
                                                                90
                                                                                                   0000000
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INTERCHANGE 1ST 2 ROWS OF THE A MATRIX AND NEGATE THE SECOND ROW
                                                                                                                                                                                                                                                                                                                                                                                         INTERCHANGE FIRST TWO COLUMNS OF COPI AND NEGATE THE 2ND COLUMN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    REMOVE ARTIFICIAL VARIABLES FROM TABLEAU, IF POSSIBLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      INTERCHANGE IDES(1) AND IDES(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    SOLVE PHASE 2 PROBLEM
CALL ZXILP (A.B.IW.RW.K.M.N.ITMAX, LIC, IR, RW(ICOPI), IW(IDES),
                                                                                                                                                                                                                                                                                                          INTERCHANGE 1ST 2 ELEMENTS OF RIGHT HAND SIDE AND NEGATE THE SECOND ELEMENT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ICOLMS(1) = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NEGATE ROW
                                                                                                                                           TEMP = A(I,J)
IF (I,LT,IA) GO TO 13U
II = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (JER.EQ.0) LIC = MIP2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   J = IW(IDES)
IW(IDES) = Iw(IDES2)
IW(IDES2) = J
IW(WIP2) = -2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     J = ICOPI+IR+IR+1

DO 150 I=ICOPI,JIR

IEMP = KW(I)

RW(I) = RW(I+1)

RW(I+1) = IEMP

150 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                     J = 1COPI+IR-1

DO 145 I=ICOPI J

TEMP = RW(I)

RW(I) = RW(I*IR)
                                                                             K = (N-1)*IR+1

DO 140 L=1,K,IR

J = (L+IA-1)/IA

I = L-(J-1)*IA
                                                                                                                                                                                                                                           JJ = J
135 A(1,J) = A(11,JJ)
A(11,JJ) = -TEMP
140 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RW(I+1K) = :ENP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  & DSUL,RW(1WK),1EF)
LIC = LICSV
S = DSUL(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 155 I=1, LIC
RW(I) = -RW(I)
155 CONTINUE
JER = 70
120 J = J+1
125 CONTINUE
                                                                                                                                                                                                           GO TO 135
                                                                                                                                                                                                                                                                                                                                                        B(2) = -B(1)

B(1) = 2ERO
                                                                                                                                                                                              1+0 = 11
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LICSV = LIC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IW(1) = 1
                                                                                                                                                                                                                          130 11 = 1 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        145 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Z ± ¥
                                               U U
                                                                                                                                                                                                                                                                                                        \circ \circ \circ
```

RE-ORDER THE PRIMAL SOLUTION

```
PERMUTE ROWS OF A AND ELEMENTS OF B
ACCORDING TO PERMUTATIONS STORED IN
RW
                                                                                                                                                                                                                                                                                                                                       ARTIFICIAL VARIABLES ARE IN THE SOLUTION HENCE NO FEASIBLE SOLUTION EXISTS
                                                                                                                                                                    GET DUAL SOLUTION
                                                                                                                                                                                                                                                                                                                                                                                                                                                     RESTORE A AND B
                                                                                                                                                                              JI = LIC+1+IR

TEMP = RW(JI)

DO 175 I=1,M12

J = ABS(RW(I))

JI = J1+IR

DSOL(J) = RW(JI)+TEMP

IF (RW(I),LT,ZERO) DSOL(J) = -DSOL(J)

IF (RW(I),LT,ZERO)

IF (I.LE,MI) DSOL(J) = ABS(DSOL(J))

I75 CONTINUE

GO TO 195
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  UNPACK A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 200 II=1.IR
A(I,J) = A(K,L)
I = I-1
K = K-1
IF (K.NE.0) GO TO 200
                                                                        165 CONTINUE

DO 170 J=1,M

K = IW(IDES+J)

IF (K.GT.N) GO TO 170

PSOL(K) = DSOL(J+1)

170 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          J = ABS(RW(I))
IF (J.EQ.I) GO TO 230
TEMP = RW(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 195 IF (IA.EQ.IR) GO TO 210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 215 J=1.N
A(1,J) = A(1+2,J)
215 CUNIINUE
220 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             K = MOD(N*IR,IA)

L = (N*IR+IA-1)/IA

J = N

D 205 JJ=1,N

I = IR
DO 160 J=1,M12
RW(J) = PSOL(J)
160 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                  RW(J) = PSOL(J)
                                             DO 165 J=1,N
PSOL(J) = ZERO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      J = J-1
205 CONTINUE
210 DO 220 I=1,M12
B(1) = B(1+2)
                                                                                                                                                                                                                                                                                                                                                                                      180 IER = 133
185 DO 190 J=1.M12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       K = IA
L = L-1
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            230 I=1,M12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      200
```

```
IF(LLWK.GE.L3+N*NV*NV+NV) GO TO 5
WRITE(UG.*)' IN DISCRIM, WK REQUIRES MOKE THAN L3+(NO+1)*(NVO+1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      8+(NVO+1)+1 = ', L3+N*NV+NV+1, ' WORDS BUT HAS AJAILABLE ONLY LLWK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           SUBROUTINE DISCRM(X.ID,K,H,NVO.NP,NO,P,D1,D2,SOS,IER)
DISCRM SEEKS HYPERPLANES DESCRIBED BY VECTOR P,SCALARS D1,D2. FOR POINT Z, Z+F GE U1 (//R LE D2 AS ID IS K OR H, BY REQUIRING D2-D1 GE O FOR OVERLAPING SETS (SOS=1),LE O FOR SEPARATED SETS (SOS=-1) MAXIMIZING D1 D2 ASSURES EITHER MIN OVERLAP OR MAX SEPARATION.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                P.DI.D2 ARE SCALED SO THAT P HAS UNIT LENGTH.

NO IS NUMBER OF PT. IN THE TWO SETS, X IS AN NP*NVO ARRAY WITHIN
AN NPMAX*NVMAX ARRAY. WK IS WORK VECTOR OF LENGTH LB, A LITTLE LT
(NVO+3)*(NO+1)+2*(NO+5)*2 IF NO GE NVO.

IER=0 IF SUCCESS; =33.34,70 IF WARRING FROM SV DECOMP OR LP
ROUTINES; =129 IF SV DECOMP FAILS;=130-133 IF LP FAILS;=135 IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DIMENSION ID(1).WK(1),P(1)
DIMENSION A(1).V(1).W(1),U(1),Q(1),TEMP(1)
DIMENSION B(1).C(1),PSOL(1),DSOL(1),RW(1),IW(1))
EQUIVALENCE (A(1),WK(1)),(V(1),WK(1)),(W(1),WK(1)),(M(1),WK(1)),(B(1),WK(1)),(B(1),WK(1)),(B(1),WK(1)),(B(1),WK(1)),(BSOL(1),WK(1)),(BSOL(1),WK(1)),(BSOL(1),WK(1)),(BSOL(1),WK(1)),(BSOL(1),WK(1)),(BSOL(1),WK(1)),(IW(1)),WK(1)),(IW(1)),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)),(IW(1),WK(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         СО I S СУМина попонина попонительного попонительно попонительно по попонительно п
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       COMMON LNPMAX, LNVMAX, LICLMAX, LNAXES, LLWK, WK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (JER.NE.0) CALL UERTST (JER, 'ZX3LP')
IF (IER.GT.JER) CALL UERTST (IER, 'ZX3LP'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PARAMETER (NPMAX=450,NVMAX=14,ICLMAX=14)
PARAMETER (NAXES=NVMAX*ICLMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (RW(1).GT.ZERO) GO TO 240
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            .EQ. 0) IER=JER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      B(I) = -B(I)
DO 235 J=1,N
A(I,J) = -A(I,J)
                                                                                                                                                                                                                                                                                                                                                                                                                    A(1,K) = A(J,
A(J,K) = TEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        L3=L2+3+MAX0(N,NV)
                                                                                                              TEMP = B(1)
B(1) = B(J)
B(J) = TEMP
DU 225 K=1,N
RW(1) = RW(J)
RW(J) = TEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 240 I=1,M12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           L2=L1+(N+3)*N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DIMENSIONS WRONG.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               M-MAXD(N.NV)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    INTEGER H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              9000 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   225 CONTINE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NV=NV0+2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (IER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       N-W-D7
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    11=10+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          9005 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           N=N0+1
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BESSELVE BESSELVE BESSELVE BOSSELVE BOSSELVE BESSELVE BES

STATE PROGRAM WANTED STATES - CONTRACT CONTRACT

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FER=135
GD TO 600
C PUT THE NO POINTS OF X MITH ID K OR H INTO N*(NV+1) MATRIX A.
C IF POINT HAS ID=K, ENTER -1,0 IN COLS NV+1,2; IF ID=H ENTER 0,+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL LSVDF(A.M.N.NV,U(L1+1),N+3,N,Q(L2+1),TEMP(L2+NV+1),IER) IF(IER.EQ.33.OR.IER.EQ.34)WRITE(06,*) WARNING: LSVDF IN & DISCRIM RETURNS IER= 1ER IF(IER.EQ.129) GO TO 600
                                                                                                    TOL=.001
IF(NPMAX.EQ.LNPMAX) 3C TO 10
WRITE(06,*)' IN DISCRIM NPMAX=',NPMAX,' BUT IN MAIN NPMAX ='
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 85 J=1,NVO

B5 A(L+1+(J-1)*M)=0.

A(L+1+NVO*M)=-SOS

A(L+1+NVO*M)=-SOS

C GET SING VALUE DECOMPOSITION OF N*NV MATRIX A AS U*Q*VTRANSPOSE
C WHERE U IS N*N (BUT IMBEDDED IN AN (N+3)*N ARRAY), Q IS N*NV,
C V IS NV**S. ONLY THE NV DIAGONAL WORDS OF Q ARE STORED. V IS
C STORED OVER A. U IS INITIALIZED TO IDENTITY. UTRANSPOSE STORED
C OVER U TEMP IS 2NV WORDS LONG

DO 120 I=1.N
                                                                                                                                                                                                                                          10 IF(NVMAX.EQ.LNVMAX) 30 TO 15 WRITE(06,*)' IN DISCRIM NVMAX=',NVMAX,' BUT IN MAIN NVMAX='
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF(L.LE.NO) GO TO 45
WRITE(06.*)' DISCRIM COUNTS MORE THAN', NO,' POINTS WITH ID'
,K,' OR',H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 GO TO 600
45 DO 50 J=1,NVO
50 A(L+(J-1)*M)=TEMP1*WK(L4+J)
                                                                                                                                                                                                                                                                                                                                                                                                                                               READ(22)(WK(L4+J),J='.NVU)
IF(ID(I).EQ.K) GO TC 2U
IF(ID(I).EQ.H) GO TS 3U
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          110 U(L1+I+(J-1)*(N+3))=0.
120 U(L1+I+(I-1)*(N+3))=1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           A(L+(NV0+1)+M)=TEMP3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      A(L+NVO*M)=TEMP2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 110 J≈1,N
                                                                                                                                                                                                                                                                                                                                                                                                                            DO 80 1=1,NP
                                         GO TO 600
                                                                                                                                                                                                                       GO TO 600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 30 TEMP1=-1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  TEMP2=-1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TEMP1=+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TEMP3=+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                80 CONTINUE
8 = ', LL *K
IER=135
                                                              S CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    GO TO 80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              GO TO 40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       TEMP3=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            1ER=136
                                                                                                                                                                       8 LINDMAX
                                                                                                                                                                                                                                                                                          S. LNVMAX
                                                                                                                                                                                                IER=135
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        TEMP2=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                OMAX=0
                                                                                   IER=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      40 L=L+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           20
```

Principal - Received - Principal - Present - Present

```
DO 150 L=1)*NV

IF(Q(L2+L).EQ.0.) GO TO 150

W(1+(J-1)*NV)=W(1+(J-1)*NV)+RW(L3+1+(L-1)*NV)*

&U(L1+L+(J-1)*(N+3))/Q(L2+L)

150 CONTINUE

160 CONTINUE

160 CONTINUE

C SET UP LP PROBLEM: (D-1)UT*PSOL=B, SUM PSOL LE 1, PSOL GE 0, CMAXIMIZE S=C*PSOL. IN CODE, INEQ CONSTRAINT AFFIXED AT BEGINNING

C OF U, AS ROW.

C OF U, AS ROW.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE(06,+)' IN DISCRIM, WK REQUIRES LB=', LB,' WORDS BUT HAS
                                                                                                                                   C REPLACE V BY W=VDOTUT, AN NV*N MATRIX. T=TRANSPOSE. D IS NV**2 C GENERALIZED INVERSE OF QTQ.

DO 145 I=1, (N*1)*(NV-1)*1

145 RW(L3+I*([I-1)/M)*(NV-M))=V(I)

DO 160 I=1,NV

DO 150 J=1,NV

W(I+(J-1)*NV)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     190 CALL ZX3LP(U(LO+1),N+3,B(L2+1),C(L3+1),N,1,ICONSTR,S,

&PSOL(L4+1),DSOL(L5+1),RW(L7+1),IW(L6+1),IER)

IF(IER.EQ.133) GO TO 600

C COMPUTE P AND D1,D2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          _______DO 170 J=1,N
DO 170 J=1,N
170 U(L!+IC@NSTR+(J-1)*(N+3))=U(L!+I+(J-1)*(N+3))
180 CONTINUE
IF(ABS(G(L2+1)).GT,UMAX)QMAX=ABS(Q(L2+1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 180 I=1,N
IF(I.LE.NV.AND.Q(L2+I).NE.O.) GO TO 180
ICONSTR=ICONSTR+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 230 J=1.N
IF(ABS(PSOL(L4+J)).LT.1.E30) GO TO 230
                                                                                     IF(ABS(Q(L2+I)).LT TOL*QMAX)Q(L2+I)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   & AVAILABLE ONLY LLWK=', LLWK GO TO 600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          L7=L6+2*ICONSTR+10
L8=L7+(ICONSTR+5)**2+1
IF(LLWK.GE.L8) GO TO 190
IER=135
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              165 U(L0+1+(J-1)*(N+3))=-505
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                L5=L4+MAX0(N, ICONSTR+2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 175 I=2, ICONSTR+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              L6=L5+ICONSTR+4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 230 I=1,NVO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 165 J=1,NO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 210 J=1,ND
210 C(L3+J)=0.
                                                            DO 140 I=1,NY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               U(L0+1+(N-1)+
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  C(L3+N)=-S0S
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   B(L2+1)=-50S
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                175 B(L2+I)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          8 (N+3))=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           I CONSTR=0
                                                                                                                   140 CONTINUE
                              130 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      P(1)=0.
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WRITE(06,*)' ENTER COUNT OF BONDED POINTS(18.) FORCED INTO SAME & CLUSTER)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE(06.+)' CHOOSE TYPICAL,SCALE OPTIONS(MIN.MAX,AVER,SIGMA
8,MID,RANGE,SPETIAL)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE(06,*)' FOR POINTS ON INPUT FILE, NOT EXCLUDED BY USER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RETURN
WRITE(06,*) WHICH OTHER VARIABLE IDENTIFIES SUBSETS (0 IF & NONE)?
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      RETURN WRITE(06.*)' ENTER N, THEN N PAIRS OF IDS TO BE LABELED AS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GO TO (1.2.3.4,5,6,7.8.9), K
1 WRITE(O6.*)' GALACTIC (GEOMETRIC ANALYSIS OF LARGE ARRAYS
& CONTAINING > 3 INDEP COORD)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CATFILExecustry sactions to the content of the conte
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          2 WRITE(06.*)' ENTER NUMBER & NAMES OF SAMPLE FILES, WORDS/
&RECORD, V/N TO CLEARFILES'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   C SETS UP FILIN(1) AS FILE 01. IF FILIN(1) 1S 0, RETURNS I=0 CHARACTER *64FILIN(1), FILECR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE(06,*) ENTER N (LE 20) THEN NAME N POINTS TO & EXCLUDED'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DI=DI+W(NVO+1+(J-1)*NV)*PSOL(L4+J)
240 D2=D2+W(NVO+2+(J-1)*NJ)*PSOL(L4+J)
NORMALIZE P TO UNIT LENGT+, ADJUST DI.D2
P(1) = P(1) + W(1 + (J - 1) + NV) + PSOL(L4 + J)
D1=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Z
Z
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    SUBROUTINE ATFILE (FILIN, I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             250 TEMPO=TEMPO+P(I)**2
IF(TEMPO.NE.0) GO TO 245
IER=IER+200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF(1,GT,1) REWIND 01
CLOSE(U1,S1A1US='KEEP')
IF(I.GT.0) GO TO 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SUBROUTINE MESSAGE(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   245 TEMP0=SQRT(TEMP0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 260 I=1,NVO
P(I)=P(I)/TEMPO
D1=D1/TEMPO
D2=D2/TEMPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE(06,*)' VAR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 250 I=1,NV0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 C PRINTS KTH MESSAGE
                                                                                                                                                                                      DO 240 J=1,N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    & THE FIRST.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                GO TO 600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            600 REWIND 22
RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                 TEMP0=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 260
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     00
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N.IV.NRV,IC.NCC,IER
D(N),E(N),V(IV.1),C(IC.1)
I.II.J.K,KK,L,LL,LP1,NQRS,N10
WNTV,HAVERS,FAIL
DNORM,ZERO,ONE,TWO.CS,F,SQINF,FTEMP,G,H,HTEMP,
                                                                                                                                                                                           0
                                                                                                                                                                                                         SUBROUTINE LSVUB (D.E.N.V.IV.NRV.C.IC.NCC.IER)
C SINGULAR VALUE DECOMPOSITION OF A BIOTAGONAL MATRIX (IMSL)
INTEGER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           SINCE D(K) IS SMALL WE WILL MAKE A SPECIAL PASS TO TRANSFORM E(K) TO ZERO.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TEST FOR SPLITTING OR RANK
DEFICIENCIES FIRST MAKE TEST FOR
LAST DIAGONAL TERM, D(K), BEING
SMALL.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL SROTG (D(I), FTEMP.CS.SN)
TRANSFORMATION CONSTRUCTED TO ZERO
WR:TE(06.*)' STOP. ATFILE CALLED WITH FILE NUMBER LE
                                                                                                                                                                                                                                                                                                        SN.T.X.V.Z
SQINF/O.13043818E+20/
ZERO/0.0/.ONE/1.0/.TWO/2.0/
FIRST EXECUTABLE STATEMENT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DNORM = AMAXI(ABS(D(J))+ABS(E(J)), DNORM)
                            IF(FILIN(I).NE.FILECR) GO TO IF(I.LE.1) REWIND 01
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (T.NE. DNORM) GO TO 25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ) 20 II=2,K
I = K+1-II
F = -SN*E(I+1)
E(I+1) = CS*E(I+1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (K.EQ.1) GO TO 25
                                                                                                                                                                                                                                                                                                                                                                             IF (N.LE.0) GO TO
N10 = 10*N
                                                                                                                                                                                                                                                                                                                                                                                                    WNTV = NRV.GT.0
HAVERS = NCC.GT.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DNORM+D(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 FIEMP # F
                                                                                                                                                                                                                                                                                                                                                                                                                                  FAIL = .FALSE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   T - D(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 100 KK=1.N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  K = N+1-KK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DNORM = ZERO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    = ZERO
                                                                                                                                                                                                                                                                                                                                                                                                                                                              E(1) = ZERO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        N.1=L 2 00
                                                                                                                                                                                                                                                                                                                                                                                                                                               NORS = 0
                                                                                                                                                                                                                                                                INTEGER
LOGICAL
                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                IER = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ıı
►
                                                                      RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  SN
SN
BO
                                                                                                                                                                                                                                                                                                                      DATA
                                                                                                                                                                                                                                                                                            REAL
                                                                                                                                                                                                                                                                                                                                    DATA
                                                                                                                                                                                  ERO
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THE MATRIX IS NOW BIDIAGONAL, AND OF LOWER CRDER SINCE E(K) . EQ. ZERO
                                                                                                                                                                                                                         THIS LOGP CANT COMPLETE SINCE E(1) = ZERO.
                                                                   ACCUMULATE RT. TRANSFORMATIONS IN V.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Z = D(K)
IF (L.EQ.K) GO TO 85
SHIFT FROM BOTTOM 2 BY 2 MINOR OF
B**(T)*B.
                                                                                                                                                                                                                                                                 CANCELLATION OF E(L), L.GT.1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (ABS(F) .LT. SQINF) G = SQRT(ONE+F**2)
IF (F.LT.ZERO) GO TO 55
T = F-G
GO TO 60
T = F-G
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                X = D(L)

Y = D(K-1)

G = E(K-1)

H = E(X)

F = ((Y-Z)*(Y+Z)+(G-H)*(G+H))/(TWO*H*V)

G = ABS(F)
                                                                                                                                                                                                                                                                                                                                                                                                         CALL SROTG (D(I), FTEMP, CS, SN)

IF (.NOT. HAVERS) GO TO 45

DO 40 J=1, NCC

CALL LSVG2 (CS, SN, C(I, J), C(L-1, J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              TEST FOR CONVERGENCE
POSITION (1,K).

IF (.NOT.WNIV) G0 T0 20
D0 15 J=1,NRV
CALL LSVG2 (CS.SN.V(J,1 1V(J,K))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        = ((X-Z)*(X+Z)+H*(Y/T-H))/X
NEXT QR SWEEP
                                                                                                                                      L = K+1-LL

T = DNORM+E(L)

IF (T.EQ.DNORM) GO TO SO

T = DNORM+D(L-1)

IF (T.EQ.DNORM) GO TO 35

CONTINUE
                                                                                                                                                                                                                                                                                                                     F = -SN*E(I)
E(I) = CS*E(I)
T = DNORM*F
IF (T.EQ.DNORM) GO TO 50
T = D(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       0 80 1=LP1 K

G = E(1)

V = D(1)

H = SN*G

G = CS*G
                                                                                                                                                                                                                                                                                                                                                                                            FTEMP = F
                                                                                                                          DO 30 LL=1,K
                                                                                                                                                                                                                                                                                                          45 I=L,K
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CS = ONE
SN = ONE
LP1 = L+1
                                                                                                                                                                                                                                                                               = 2ERO
                                                                                  CONTINUE
                                                                                                                                                                                                                                                    60 10 50
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                               SS SS
                                                                                 20
                                         15
                                                                                                                          25
                                                                                                                                                                                                          30
                                                                                                                                                                                                                                                                                35
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45
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           50
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60
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                U
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CUTOFF FOR CONVERGENCE FAILURE. NORS

WILL BE 2*N USUALLY.

D(K) = -Z

IF (.NOT.WNTV) GO TO 95

DO 90 J=1,NRV

V(J,K) = -V(J,K)

CONTINUE
                                                                                                                                                                                                                                                                      APPLY ROTATIONS FROM THE LEFT TO RIGHT MAND SIDES IN C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                EVERY SINGULAR VALUE IS IN ORDER
                                                                                    IF (.NOT.A.T.) GO TO 70
ACCUMULATE ROTATIONS (FROM THE RIGHT) IN V
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONVERGENCE, D(K) IS MADE NONNEGATIVE
                                                                                                                           DO 65 J=1,NR.
CALL LSVG2 (CS.SN.V(J.I-1),V(J.I))
HTEMP = H
                                                                                                                                                                                                                                            (S. SN. C(I-1.J), C(I,J))
                                                                                                                                                             CALL SROTG (F.HTEMP.CS.SN)
D(1-1) = F
F = CS*G+Sh*.
X = -SN*G+CS*.
IF (.NOT.HA.ERS) GO TO 80
DO 75 J=1.**C
CALL LSVG2 CS.SN.C(1-1,J).C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           100 CONTINUE

IF (N.EQ.1) GO TO 140

DO 105 I=2.N

IF (D(I).GI.D(I 1)) GO TO 110
        CALL SROTG (F, HTEMP, CS, SN)
E(1-1) = F
F = X*CS+G*SN
G = -X*SN+G*CS
H = Y*SN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 115 J=1,N
IF (",GE.D(J)) GO TO 115
T = D(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE

IF (K.EQ.1-1) GO TO 135

D(K) = D(I-1)

O(I-1) = I

IF (.NOT.HAVEPS) GO TO 125
                                                                                                                                                                                                                                                                                                                                   D(K) - X
NQRS = NQRS+1
ITEMP " I
                                                                                                                                                                                                                                                                                              CONTINUE
F(L) = ZERG
E(K) F
                                                                          V = V◆CS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       110 D0 135 I=2,N

T = D(I-1)

K = I-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 GO TO 140
                                                                                                                                                                70
                                                                                                                                        65
                                                                                                                                                                                                                                                                                                9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               90
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   115
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SUBROUTINE LSvDF (A,1A,M,N,B,1B,NB,S,WK,1ER)
C SINGULAR VALUE DECOMPOSITION OF A REAL MATRIX (IMSL)
C IER=33 MEANS MATRIX A IS NOT OF FULL RANK OR VERY ILLCONDITIONED
C SMALL SINGULAR VALUES MAY NOT BE VERY ACCURATE.
C 34 EITHER N.LE.O OR M.LE.O
C 129 CONVERGENCE WAS NOT OBTAINED BY LSVDB. COMPUTATION
C WAS DISCONTINUED.
                                                                                                                                                                                                                                                                                                                                                                                                                                                         COL J IS ZERO, EXCHANGE IT WITH COL
N
                                                                                                                                                                                                                                     CHECK FOR POSSIBLE RANK DEFICIENCY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IA.M.N. IB.NB. IER
A(IA.N), B(IB.1), S(N), WK(N, 2)
I.J. JP1, K.L.MM.NN.NNP1, NS, NSP1
ZERO, ONE, T
ZERO/O.O/, ONE/I.O/
FIRST EXECUTABLE STATEMENT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    C BEGIN SPECIAL FOR ZERO ROWS & COLS. PACK THE NONZERO C COLUMNS TO THE LEFT
                                                                                                                                                                                END OF ORDERING ALGORITHM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IER = 34
IF (NN.LE.O.UR.M.LE.O) GO TO 9000
IER = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 10 I=1,M
IF (A(I,J).NE.ZERO) GO TO 25
                                                                                                                                                                                                                                                                                    IF (D(1).NE.ZERO) T=D(N)/D(1)
F=100.0+T
IF (F.EQ.100.0) GO TO 9000
IER = 0
GO TO 9005
                                C(I-1,J) = C(K,J)
C(K,J) = T
IF (.NOT.WNTV) GO TO 135
DO 130 J=1.NRV
T = V(J,I-1)
V(J,I-1) = V(J,K)
                                                                                                                                                                                                                                                                                                                                                                                              CALL UERTST (IER, 'LSVDB ')
9005 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (J.EQ.NN) GO TO 20
DO 15 I=1,M
                                                                                                                                                                                              140 IER = 129
IF (FAIL) GO TO 9000
                  = C(I-1,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           15 A(I,J) = A(I,NN)
20 CONTINUE
A(I,NN) = J
NN = NN-1
DO 120 J=1,NCC
                                                                                                                                          V(J,K) = T
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                J = NN
CONTINUE
                                                                                                                                           130 V(J,K
                                                                                                                                                                                                                                                       IER = 33
                                                                                                                                                                                                                                                                                                                                                                             9000 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       10 CONTINUE
                                                                                                                                                                                                                                                                      T = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      INTEGER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            INTEGER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     1ER = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Z 11 ZZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DATA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             REAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           REAL
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(2) APPLY H(N)...H(1) TO B. HERE H(N)...H(1)*B REPLACES B IN STORAGE.

(3) THE MATRIX PRODUCT W= Q(1)...Q(N-2) OVERWRITES THE FIRST N ROWS OF A IN STORAGE.

(4) AN SVD FOR D IS COMPUTED. HERE K ROTATIONS RI AND PI ARE COMPUTED SO THAT RK...RI*D*PI**(T)...PK**(T) = DIAG(S1...,SM) TO WORKING ACCURACY THE SI ARE NONNEGATIVE AND NONINGRASING. HERE RK...RI*B OVERWRITES B IN STORAGE WHILE A*PI**(T)...PK**(T) OVERWRITES A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           BEGIN SVD ALGORITHM..

(1) REDUCE THE MATRIX TO UPPER
BIDIAGONAL FORM WITH HOUSEHOLDER
TRANSFORMATIONS.

H(N)...H(1)AQ(1)...Q(N-2) =
(D**1,0)**T WHERE D IS UPPER
BIDIAGONAL.
                                                                                                                                                                                                                                                                                                        ROW I IS ZERO EXCHANGE ROWS I AND M
DO 50 J=1,NB
                                                  IF N=0 THEN A IS ENTIRELY ZERO AND SVD COMPUTATION CAN BE SKIPPED
                                                                                                                    PACK NONZERO ROWS TO THE TOP QUIT PACKING IF FIND N NONZERO ROWS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END SPECIAL FOR ZERO ROWS AND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           EXCHANGE IS FINISHED
                                                                                                                                                                                                                     DO 35 J=1,NN
IF (A(1,J).NE.ZERO) GO TO 40
                                                                                                                                                                                       IF (I.GT.N.OR.I.GE.MM) GO TO IF (A(I,I).NE.ZERO) GO TO 40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               COLUMNS
                                                                                  NS = 0
IF (NN.EQ.0) GO TO 120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    A(I.J) = A(MM.J)
IF (MM.GT.NN) GO TO 70
DO 65 J=1.NN
                                   IF (J.GE.1) GO TO 5
                                                                                                                                                                                                                                                                                                                                                                               T = B(I,J)

B(I,J) = B(MM,J)
                                                                                                                                                                                                                                                                                                                                                                                                                  B(MM, J) = T
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        A(MM, J) = ZERO
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 60 J=1, NN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          MtA = MM - 1GO = V - 30
25 CONTINUE
                                                                                                                                                                                                                                                                           GO TO 45
                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           75 CONTINUE
                                                                                                                                                                                                                                                                                           I = I + I
                                                                                                                                                                                        30
                                                                                                                                                                                                                                                           35
                                                                                                                                                                                                                                                                                            40
                                                                                                                                                                                                                                                                                                                                               45
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55
60
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DO 85 J=1,L

IF (J.GE.MM) GO TO 80

JP1 = MINO(J+1,NN)

CALL VHS12 (1,J,J+1,MM,A(1,J),1,T,A(1,JP1),1,IA,NN-J)

CALL VHS12 (2,J,J+1,MM,A(1,J),1,T,B,1,IB,NB)

BO IF (J.GE.NN-1) GO TO 85

CALL VHS12 (1,J+1,J+2,NN,A(J,1),IA,WK(J,2),A(J+1,1),IA,1,MM-J)

85 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 115 K=1,NN

I = NN+1-K

I F (I.GT.MINO(MM.NN-2)) GO TO 105

CALL VHS12 (2.I+1,I+2,NN,A(I,1),IA,WK(I,2),A(I,I+1),1,IA,NN-I)

DO 110 J=1,NN

A(I,J) = ZERO

A(I,J) = ONE

CUNTINUE
                                                                                                                THE FOLLOWING LOOP REDUCES A TO UPFER BIDIAGONAL AND ALSO APPLIES THE PREMULTIPLYING TRANSFORMATIONS
IN STORAGE.

(5) IT FOLLOWS THAT, WITH THE PROPER DEFINITIONS. U**(T)*B OVERWRITES B. WHILE V OVERWRITES THE FIRST N ROW AND COLUMNS OF A.
                                                                                                                                                                                                                                                                                                                                                 CUPV THE BIDIAGONAL MATRIX INTO THE ARRAY S FOR LSVDB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PRODUCT MATRIX, W=Q1*Q2*...*QL*IN THE ARRAY A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             COMPUTE THE SVD OF THE BIDIAGONAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONSTRUCT THE EXPLICIT N BY N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               LEVEL-!
CALL UERSET(LEVEL.LEVOLD)
CALL LSVDB (S(!).WK(!,!),NS.A.IA,NN,B,IB.NB.IER)
TEST FOR IER=33
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (S(1).NE.ZERO) T=S(NM)/S(1)
F=100.0+T
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 MATRIX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (IER.GT.128) GO TO 9000
CALL UERSET(LEVOLD,LEVOLD)
IF (IER.NE.33) GO TO 120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (F.EQ.100.0) GO TO 120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NS = NN
IF (MM.GE.NN) GO TO 100
NS = MM+1
S(NS) = ZERO
                                                                                                                                                                                                                                                                                                                                                                                                              WK(J,1) = A(J-1,J)
90 CONTINUE
95 '')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WK(NS,1) = A(MM,MM+1)
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                       (L.EQ.1) GO TO 95
90 J=2,L
                                                                                                L = MINO(MM,NN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            NM=MINO(M.N)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           1=0.0
                                                                                                                                                                                                                                                                                                                                                                                         ۳ 8
1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          100
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PERMUTE ROWS AND SET ZERO SINGULAR
                                                                                                                                    MOVE RECORD 3F PERMUTATIONS AND STORE ZERUS
                                                                                                                                                                                                                                                                                                                                                                                                                               END SPECIAL FOR ZERO ROWS AND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      SUBROUTINE LSVGI (A.B.CS.SN.SIG)
C NUCLEUS CALLED ONLY BY IMSL ROUTINE LS.DB
REAL A.B.CS.SN.SIG
REAL AA.BB
                IF (NS L), MINO(M,N)) IER = 33
IF (NS,GE,NN) GO 10 130
NSP1 = NS+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (ABS(A), LE.ABS(B)) GO TO S
AA = ABS(A+A)
SIG = AA*SQRT(0.25+(B/AA)**2)
CS = A/SIG
SN = B/SIG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            5 IF (B.EQ.0.0) GO TO 10
BB = ABS(B+B)
SIG = BB*SQRT(0.25+(A/BB)**2)
CS = A/SIG
SN = B/SIG
                                                                                                                                                                                                                                                                                                                                                                                                                                         COLUMNS
155 1F (1ER.EQ.D) GO TO 9005
9000 CONTINUE
                                                                                                                                                                                                                                                                                   VALUES
                                                                                                                                                                      DO 140 J=NNP1,N

S(J) = A(1,J)

IF (NN.LT.1) GO TO 140

DO 135 I=1,NN

A(1,J) = ZERO

140 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL UERTS* (IER, LSVDF ')
                                                                                                                                                                                                                                                                                                                I = S(K)

S(K) = ZERO

BO 145 J=1,N

A(K,J) = A(I,J)

145 A(I,J) = ZERO

A(I,K) = ONE

150 CONTINUE
                                                                                                          IF (NN.EQ.N) GO TO 155
NNP1 = NN+1
                                                           DO 125 JENSPI,NN
125 S(J) = ZERO
130 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IMSL ROUTINE NAME
                                                                                                                                                                                                                                                                                                    DO 150 K=NNP1,N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           10 516 = 3 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            C5 = 0.0
SN = 1.0
120 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          9005 RETURN
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I, IEQ, IEQDF, IOUNIT, LEVEL, LEVOLD, NAMEQ(6), NAMSET(6), NAMUPK(6), NIN, NMTB
NAMSET/IHU, IHE, IHR, IHS, IHE, IHT/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CUERSETameaturations and accessors and access
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CUERTSTannocuskaarokaanakakakakakakakanakakanakannaka
(IER_LE_64) GO TO 10
(LEVEL.LT.2) GO TO 30
PRINT WARNING WITH FIX MESSAGE
(IEQDF.EQ.1) WRITE(IOUNIT.40) IER.NAMEQ.IEQ.NAMUPK
(IEQDF.EQ.0) WRITE(IOUNIT.40) IER.NAMUPK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (LEVEL.LT.3) GO TO 30
IF (IEODF.EQ.1) WRITE(IOUNIT.45) IER.NAMEO.IEQ.NAMUPK
IF (IEQDF.EQ.0) WRITE(IOUNIT,45) IER.NAMUPK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     (IEQDF.EQ.1) WRITE(IOUNIT,35) IER,NAMEQ,IEQ,NAMUPK
(IEQDF.EQ.0) WRITE(IOUNIT,35) IER,NAMUPK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DATA LEVEL/4/, IEQDF/0/, IEQ/1H=/
UNPACK NAME INTO NAMUPK
CALL USPKD (NAME, 6, NAMUPK, NMTB)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   GET OUTPUT UNIT NUMBER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PRINT TERMINAL MESSAGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PRINT WARNING MESSAGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CHECK FOR UERSET CALL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 20 1=1.6
IF (NAMUPK(I).NE.NAMSET(I)) GO TO 25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           SUBROUTINE UERSET (LEVEL, LEVOLD)
INTEGER
LEVEL, LEVOLD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NAMEQ/6+1H /
                                                                                  SUBROUTINE LISTURE (LISTSNIK, V)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      LEVOLD = LEVEL
CALL UERTST (LEVOLD, UERSET')
                                                                                                                                                                                 CS.5N.X.V
XR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             SUBROUTINE UERTST (TER, NAME)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CHECK IER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL UGETIO(1, NIN, IOUNIT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (IER.GT.999) GO TO 25
IF (IER.LT.-32) GO TO 55
IF (IER.LE.128) GO TO 5
IF (LEVEL.LT.) GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (IEQDF.EQ.1) WRITE(IO
IF (IEQDF.EQ.0) WRITE(IO
GO TO 30
IF (IER.LE.32) GO TO 15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        LEVOLD = LEVEL
LEVEL = IER
IER = LEVOLD
                                                                                                                                                                                                                      REAL
XR=CS*X+SN*Y
Y=-SN*X+CS*Y
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CHARACTER*6
Integer
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            10 30
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            GU TO 3U
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              INTEGER
                                                                                                                                                                                                                                                                                                                                                                                                    RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             RETURN
                                                                                                                                                                                                                                                                                                                                                      XIXE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DATA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DATA
                                                                                                                                                                                                                                                                                                                                                                                                                                                 END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     4 6 6 4 4
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(PACKED, NCHARS, UNPAKD, NCHMTB)
L ROUTINES THAT HAVE CHARACTER STRING ARG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SET NC=NUMBER OF CHARS TO BE DECODED
                                                IF (LEVEL.LT.4) J. 70 30

IF (IEQDF.EQ.1) AFITE(IOUNIT.50) IER.NAMEQ.IEQ.NAMUPK

30 IEQDF = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CHECK UNPAKD ARRAY AND SET NCHMTB
                                                                                                                                                      35 FORMAT(19H *** TERMINAL ERROR, 10X, 7H(IER = ,13, 20H) FROM IMSL ROUTINE ,6A1,A1,6A1)
40 FORMAT(27H *** WARNING WITH FIX ERROR, 2X, 7H(IER 8 20H) FROM IMSL ROUTINE ,6A1,A1,6A1)
45 FORMAT(18H *** WARNING ERROR, 11X, 7H(IER = ,13, 8 20H) FROM IMSL ROUTINE ,6A1,A1,6A1)
50 FORMAT(2DH *** UNDEFINED ERROR, 9X, 7H(IER = ,15, 8 20H) FPOM IMSL ROUTINE ,6A1,A1,6A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RETURN IF NCHARS IS LE ZERO
                                                                                                                                                                                                                                                                                                       SAVE P FOR P = R CASE
P IS THE PAGE NAMUPK
R IS THE ROUTINE NAMUPK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          INITIALIZE NCHMTB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NC = MIND (129, NCHARS)
READ (PACKED, 150) (UNPAKD(I), I=1, NC)
FORMAT (12941)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NC. NCHARS, NCHMTB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        UNPAKD(1), IBLANK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NIND, NOUTD
NIND/5/, NOUTD/6/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           BLANK / 1H /
IF (10PT.EQ.3) GO TO 10
IF (10PT.EQ.2) GO TO 5
IF (10PT.NE.1) GO TO 90U5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           PACKED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF(NCHARS.LE.U) RETURN
                                                                                                                                                                                                                                                                                                                                                     55 IEQDF = 1
00 60 I=1,6
60 NAMEQ(I) = NAMUPh(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           SUBROUTINE USPKD (
C NUCLEUS CALLED BY IMSL
INTEGER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NIN = NIND
NOUT = NOUTD
GO TO 9005
NIND = NIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             G0 T0 9005
NOUTD = NOUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CHARACTER+6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NCHMTB = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    INTEGER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           INTEGER
                                                                                                                                             RETURN
                                                                                                                                                                                                                                                                                                                                                                                                     RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             9005 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DATA
                                             25
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SUBROUTINE VHS12 (MODE,LP,L1,M,U,INCU,UP,C,INCC,ICV,NCV)
C REAL HOUSEHOLDER TRANSFORMATION - COMPUTATION & APPLICATIONS
INTEGER MODE,LP,L1,M,INCU,INCC,ICV,NCV
REAL U(1),UP,C(1)
INTEGER IJ,ILP,ILI,IM,INCR,I2,I3,I4,J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 SM = SM+(DBLE(U(ILP))*CLINV)**2
DO 10 IJ=IL1,IM,INCU
SM = SM+(DBLE(U(IJ))*CLINV)**2
CONVERT DBLE. PREC. SM TO SNGL.
PREC. SM1
BASED ON TRAILING BLANKS FOUND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONSTRUCT THE TRANSFORMATION
                                                                                                                                                                                                                                                                                                                                                                                                                            IF (0.GE.LP.OR.LP.GE.LI.OR.LI.GT.M) G0 T0 9005
ILP = (LP-1)*INCU+1
IL1 = (L1-1)*INCU+1
IL1 = (M-1)*INCU+1
CL = ABS(U(ILP))
                                                                                                                                                                                                                                                                                                                                               ONE.CL.CLINV.SM1
FIRST EXECUTABLE STATEMENT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     APPLY THE TRANSFURMATION

1+U*(U**T)/B TO (...

15 IF (CL.LE.0.0) GO TO 9005

20 IF (NCV.LE.0) GO TO 9005

B = DBLE(UP)*U(ILP)

B MUST BE NONPOSITIVE HERE. IF B = 0. RETURN.

IF (B.GE.0.0) GO TO 9005

B = ONF/A
                                                          IF (UMPAKD(NN) .NE. IBLANK) GO TO 210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CL = CL*SQRT(SM1)
IF (U(ILP).GT.0.0) CL = -CL
UP = U(ILP)-CL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      00 5 1J=1L1, 1M, INCU
CL = AMAX1(ABS(U(IJ)), CL)
IF (CL.LE.0.0) GO TO 900S
CLINV = ONE/CL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             I2 = I-ICV+INCC*(LP-1)

INCR = INCC*(L1-LP)

D0 35 J=1,NCV

I2 = I2+ICV

I3 = I2+INCR

I4 = I3

SM = C(I2)*DBLE(UP)

D0 25 IJ=IL1,IM,INCU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  (MODE.EQ.2) GO TO 15
                    DO 200 N = 1,NC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        U(ILP) = CL
GO TO 20
                                                                                                                    210 NCHMTB = NN
                                       NN H NN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                B = 0NE/B
                                                                                 200 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                         _
|-
                                                                                                                                           RETURN
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                                                                                                                                                                                                                                                                                                                                                                                         ONE
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NOTE THAT U AND R HAVE THE SIGN OF SB (R IS IMMEDIATELY STORED IN SA)
                                                                                                                                                                                                                                                                         SPECIFICATIONS FOR LOCAL VARIABLES
                                                                                                                                                                                                                                                                                                                                                                           NOTE THAT U AND R HAVE THE SIGN OF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SPECIFICATIONS FOR ARGUMENTS SA.SB.SC,SS
                                                                                                                                                                                                                                                                                                      FIRST EXECUTABLE STATEMENT
                                                                                                                                                                                                                                                                                                                                    HERE ABS(SA) . GT. ABS(SB)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        HERE ABS(SA) . LE. ABS(SB)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NOTE THAT SS IS POSITIVE
                                                                                                                                                                                                                                                                                                                                                                                                                        NOTE THAT SC IS POSITIVE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          HERE SA = SB = 0.
                                                                       C(12) = C(12)+SM*DBLE(UP)
DO 30 IJ=IL1,1M,1NCU
C(14) = C(14)+SM*DBLE(U(IJ))
14 = 14+1NCC
SM = SM+C(13)*DBLE(U(1J))
13 = 13+INCC
CONTINUE
1F (SM.EQ.0.0) GO TO 35
SM = SM*B
                                                                                                                                                                                                                                                                                                                  IF (ABS(SA). LE. ABS(SB)) GO TO 5
                                                                                                                                                                                                                  SUBROUTINE SROTG (SA, SB, SC, SS)
                                                                                                                                                                                                                                                                                         ٧.٥.٨
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  SS = SB/SA

SC = V*(SS+SS)

IF (SC.EQ.0.) GO TO 10

SB = 1./SC

RETURN

10 SB = 1.

RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      5 IF (SB.EQ.0.) GO TO 15
U = SB+SB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            = SQRT(.25+V**2)*U
                                                                                                                                                                                                                                                                                                                                                                                                     R = SQRT(.25+V**2)*U
                                                                                                                                                                                                                                                                                                                                                                                                                                 SC = SA/R
SS = V*(SC+SC)
SB = SS
SA = R
                                                                                                                             30 CONTINUE
35 CONTINUE
9005 RETURN
END
                                                                                                                                                                                                                                                                                                                                              U = SA+SA
V = SB/U
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               SA = 0.
SB = 0.
RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      sc = 1.
ss = 0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          RETURN
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C THIS SUBROUTINE SCRTS THE INTEGER ARRAY IAR(I) (NREC ELEMENTS LONG)
C IN ASCENDING ORDER
DIMENSION IAR(I)
10 ISWAP-0
DO 50 I=2.NREC
IF (IAR(I).LT.IAR(I-1)) THEN
ITEMP=IAR(I)
IAR(I)=ITEMP
ISWAP=1
END IF
SO CONTINUE
IF (ISWAP.EQ.I) GO TO 10
RETURN
END

<u>Appendix B</u> - GALACTIC Hyperplanes

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File \$1\$DUA3:[ENGR.CASEY]FLPLANES.DAT;2 (677,23,0), last revised on 17-JUL-1987 16:08, is a 66 block sequential file owned by UIC [CASEV]. The records are variable length with FORTRAN (FTN) carriage control. The longest record is 75 bytes.

started Job FLPLANES (1614) queued to TXA15 on 17-JUL-1987 16:09 by user CASEV, UIC [CASEV], under account 6761 at priority 100, printer \_AEE251\$TXA15; on 17-JUL-1987 16:09 from queue TXA15.

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Appendix C - EFAGHY Listing

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OI C þ 20-JUL-1987 17:12, is a 1°2 block sequential file owned (CR) carriage control. The longest record is 72 bytes. File \_\$1\$DUAO:[]EFBLBN.FOR;216 (5654,282,0), last revised on [DEO1,DECNET]. The records are variable length with implied

Job EFBLBN (432) queued to TXA15 on 20-JUL-1987 17:13 by user DECNET, UIC [DEU1,DECNET], under account 9903 at priority 100. started on printer \_AEE251\$TXA15; on 20-JUL-1987 17:56 from queue TXA15.

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PARAMETER (INTERNAL OLISETMAX + 1) PETMAX + 1) PARAMETER (INTERNAL OLISETMAX + 2) PARAMETER (INTERNAL OLISETMAX + 4) PARAMETER (INTERNAL OLISETMAX + 4) PARAMETER (INTERNAL OLISETMAX + 4) PARAMETER (INFLMAX + 4) PARAMETER (INTERNAL OLISETMAX + 5) PARAMETER (INTERNAL OLISETMAX + 6) PARAMETER + 8 DATE (INTERNAL OLISETMAX + 6)
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FORMAT(IS.IG.10X,A1,F10.5,F10.5,F10.5,A1,10X,IG)
FORMAT(IS.IG.10X,A1,F10.5,F10.5,F10.5,A1,10X,IG)
FORMAT(IS.2IG.15,A1,I4,315,A1,F4.1,F5.1,F6.1,A1,F5.1,A1,F5.1,A1)
FORMAT(A5,A6,I6,I5,A1,I4,315,A1,F4.1,F5.1,F6.1,A1,F5.1,A1,F5.1,A1)
FORMAT(A7,A14,F8.3)
                                  (INMXMX=20, ISETMAX=14)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ,13F5.2)
   (NVMAX=14)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     FORMAT(A3, 14, 1315)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       REAL LHS1,LHS?
ISTOP=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CHCLS=' CLUSTR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    FORMAT (10F7.3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CHTSH= 'TSHARE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                18IIS=2**30-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CHBAT='BATCH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            VBIGN0=1.E30
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     LOGICAL EXIS
INTEGER H
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              FORMAT (1514)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CHN01= 'NOT
                               PARAMETER
PARAMETER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CHASK: +:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CHSET= '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   FILECR='
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CHLB= . |
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CHRB= 1
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CHY - Y
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HUNN S.

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WRITE(06.*)' ENTER NUMBER & NAMES OF DATA FILES, WORDS/RECORD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF(IMODE.EQ.0)WRITE(06.*)NFILE, '', (FILIN(I), I=1, MINO(NFILE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    READ(05,*)NFILE,(FILIN(I),I=1,MINO(NFILE,NFILMAX-1)),INMAX,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               84.2.1.1.4.1.1.4.4.4.22.15.1.1.11.1.1.1.1.1.1.1.1.1.1.3.2.1.1.
84.1.1.3.2.3.31.13.2.4.31.13.2.4.31.13.2.4.73.73.15.
855.22.15.3.31.13.2.4.31.13.2.4.31.13.2.4.73.73.15.
8204.23.13.2.13.21.15.56.22.15.13.7.73.73.201.201.73.209.201.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        &NFILMAX-1) INMAX, 'CHCF
IF(NFILE.GT.NFILMAX-1) WRITE(06,*)' CAN ACCEPT ONLY FIRST'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL PIIME(TIMEIN)
WRITE(06.*)
*WRITE(06.*)
*GALACIOC.*)
*GALACITC HYPERPLANES)
*CHMODE=CHTSH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ON . A7)
                                                                                                             · HOURS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(06,150)DATE1,TIME1,CHMODE
150 FORMAT('RUN ON',AB,'AT',F6.2,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF(IMODE.EQ.0) CHMODE=CHBAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL DATIM(DATE: TIME!)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             & V/N TO CLEARFILES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 155 K=1,NFILMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     155 FILIN(K)=FILECR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                FORMAT (72(1H=)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            I MODE = MCDE(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  120 WRITE(06,140)
130 CALL DATIM(DA)
140 FORMAT(72(1H=
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE(06.*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               (========)
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READ(05,*) NPERT
IF(NPERT.NE.0) THEN
WRITE(06,*)' ENTER RECORD OF FRACTIONS FOR +/- PERTURBATIONS'
READ(05,*) (PERTURB(I).I=1,INMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(06,*)' ENTER 0,1 TO NOTPERTURB, PERTURB INPUT DATA FILES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE(06,*) SET ASSIGNMENT FILE, FILEVOTE , ALREADV EXISTS. WRITE(06,*) ENTER 1 TO OVERWRITE, 2 TO ENTER NEW NAME. READ(05,*) IOVERW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          .. 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF(IOVERW.NE.1 .AND. IOVERW.NE.2) THEN WRITE(06.*)' MUST ENTER I OR 2. PLEASE TRY AGAIN.' GO TO 180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   OPEN(IOVOTE,FILE=FILEVOTE,STATUS='NEW',IOSTAT=ISTAT,
ACCESS='SEQUENTIAL',FORM='FORMATTED')
IF(ISTAT.NE.O) THEN
                                                                                                                                           WRITE(U5,*)' NAME GALACTIC HYPERPLANE FILE'
FILEHO=FILECR
READ(05,*) FILEHO
IF (IMODE, EQ. 0) WRITE(06,*) FILEHO
IF (FILEHO, EQ. FILECR) GO TO 257
OPEN(07, FILE=FILEHO, STATUS='OLD', IOSTAT=ISTAT, ACCESS=
B.SEQUENTIAL', FORM='FORMATTED')
IF (ISTAT, NE, 0) THEN
WRITE(06,*)' ERROR OPENING GALACTIC HYPERPLANE FILE.
8 ISTAT=', ISTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE(06,*)' NAME OUTPUT FILE FOR SET ASSIGNMENTS ,''
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE(06.*)' '
WRITE(06.*)' ERROR OPENING SET ASSIGNMENT FILE.'
'ISTAT=', ISTAT
&NFILMAX-1
&, OF',NFILE, FILES OFFERED'
REMCF='REMOVE CLEARFILES\'
IF(CHCF.EQ.CHY.AND.IMODE.EQ.1)CALL CALLSS(REMCF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IPERTT=0
DO 160 I=1.INMAX
IF(PERTURB(I).NE.0) IPERTT=IPERTT+1
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ(05,*) FILEVOTE
IF(IMODE.EQ.0) WRITE(06,*) FILEVOTE
175 IOVOTE=06
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF(FILEVOTE.EQ.FILECR) GO TO 210
INQUIRE(FILE=FILEVOTE.EXIST=EXIS)
IF(.NOT.EXIS) THEN
IOVOTE=08
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(IMODE.EQ.1) THEN WRITE(06.*)' WRITE(06.*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF(EXIS) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   FNO IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              STAT=0
                                                                                                                                                                                                                                                                                                                                                                                                  STOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        180
                                                                                                                                                                                                                                                                                                                                                                                                                                                  ں
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259 SIOP 10
260 FORMAT('IMPOSSIBLE INPUT INTERPRETED AS CUE TO RESTART RUN.)
290 WRITE(Ub.*)' ENTER N (LE', ISETMAX,'') THEN ID OF N SETS TO BE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       OPEN(IOVOTE,FILE=FILEVOTE,STATUS='OLD',IOSTAT=ISTAT',
ACCESS= SEQUENTIAL',FORM='FORMATTED')
IF(ISTAT.NE.0) THEN
WRITE(OG.*)' FRROR OPENING SET ASSIGNMENT FILE.'
ISTAT=',ISTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    READ(U5, *) NSETOUT, (ISETOUT(I), I=1, MINU(NSETOUT, ISETMAXI))
                                                                                                                                                                                                                                                                                                                                                                          CALL PTIME(TIMEOUT)
WRITE(FILEVOTE,181)INT((TIMEOUT-TIMEIN)*3600.*1000.)
                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE(06,*) NAMING SET ASSIGNMENT FILE FILEVOTE
OPENLIOVOIE FILE=FILEVOIE STATUS="NEW", 10STAT=ISTAT,
ACCESS= SEQUENTIAL", FORM="FORMATTED")
IF(1STAT.NE.U) THEN
WRITE(06,*) ERROR OPENNING SET ASSIGNMENT FILE.
ISTAT=", ISTAT"
                                                                                                                                                                                          IF(IOVERW.EQ.2) THEN
WRITE(O6,*)' ENTER NAME OF SET ASSIGNMENT FILE'
' (' ' ' IF NONE)'
READ(O5,*)FILEVOTE
GO TO 175
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                210 DO 190 K=1,NSPAIR
READ(07,*) (ITEMPM(K,J),J=1,2),(TEMPM(K,J),J=3,INMAX+4)
190 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                C READ FILEHO INTO TEMPM IN FORMAT: ISETID(I), ISETID(J), C CONSTANTS FGR PAIR OF PLANES, INMAX COEFFICIENTS
IF (IOVERW.EQ.1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(IMODE.EQ.0) GO TO 259
WRITE(06,260)
GO TO 120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ISETCOM(I)=0
ISETCOM(I+ISETMAX1)=0
ISETOUT(I)=0
DO 215 J=1, ISETMAX
DO 215 K=1, ICH
                                                                                                                                                                                                                                                                                                                                                   IF(INODE.EQ.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DU 220 I=1, ISETMAX1
NPINSET(1)=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IDCH01CE(J,K,I)=0
                                                                                                                            STOP
                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                                       FORMAT(18)
                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                        END 1F
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  STOP STOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                & EXCLUDED'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  COUTPUT=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                NSETOUT=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END 1F
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     215 CONTINUE
220 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NPTOUT=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         I OMAX=7
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             257
                                                                                                                                                                                                                                                                                                                                                                                                                       181
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IF(IMODE.EQ.O)WRITE(06,*)NSETOUT, (ISETOUT(I), I=1, MINO(NSETOUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             W1(K,3)=PLOWER

IF(IER.NE.O) THEN

WRITE(IOVOTE,*)' IER=', IER', FROM BELBIN. TRIALS, SUCCESSES

I. IW1(K,2), IW1(K,1),' K=', K

W1(K,3)=0.
                                                                                                                                                                  #PITE(06,*)' ENTER N, THEN N PAIRS OF 1DS TO BE LABELED & AS THE FIRST'
READ(05,*)NSETCOM, (ISETCOM(1), I=1,2*MINO(NSETCOM, ISETMAX!))
IF(IMODE, EQ. 0)
&WRITE(06,*)NSETCOM, (ISETCOM(1), I=1,2*MINO(NSETCOM, ISETMAX!))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE(06,*)' ENTER 0 GK 1 TO NOTWRITE OR WRITE THE FOLLOWING & OUTPUT OPTIONS!
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          OO 280 K≃1,NSFAIR
CALL BELBIN(IW1(K,2),IW1(K,1),ALPHA,PHAT,PLOWER,PUPPER,IER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL BELBIN(IW2(K,2),IW2(K,1),ALPHA,PHAT,PLOWER,PUPPER,IER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ALPHA = .50
IF(IDIGIT(IOUTPUT,IOMAX-2),NE.0.0R.IDIGIT(IOUTPUT,IOMAX-3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF(IDIGIT(IOUTPUT,IOMAX=6).NE.0) THEN
#RITE(06,*)' ENTER N (LE 20) THEN N RECORD NUMBERS FOR
& HYPERPLANE/PUINT OUTPUT'
READ(05,*) NHPT,(IHP:(I),I=1,MINO(20,NHPT))
NHPT =MINO(NHPT,20)
                                                                                                                                                                                                                                                                                                                                                                                                                           READ(05,*) NPLANIN, (IFLANE(I), I=I, MINO(NPLANIN, NPLANMX))
                                                                                                                                                                                                                                                                                                                                                WRITE(OB,*)' ENTER N THEN THE N HYPERPLANES TO BE USED
B(O D FOR ALL)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 299 K=1,NSPAIR
WRITE(10VOTE,*)'TO SEPARATE SETS ',ITEMPM(K,1),' &
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(IOVOTE,*)' P VOTE CONFIDENCE LEVEL =',ALPHA
                                                                            OF', 14)
                    6. [SETMAX!))
IF(MSETQUT.GT.ISETMAX!)WRITE(06,295)ISETMAX
295 FORMAT( DATA IGNORED BEYOND DIMENSION LIMIT
IF(NSETQUT.LT.0.AND.IM3DE.EQ.1) GO TO 257
IF(NSETQUT.LT.0.AND.IM3DE.EQ.0) STOP 11
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE(IOVOTE,*)(TEMPM(K,J),J=3,INMXMX4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE(06,*) ' HVP, PTS, V(T, ASS, ASP, ASC, HPT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ(05,*) IOUTPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE(IOVOTE.*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(IER.NE.O) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           W2(K,3)=PLOWER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ITEMPM(K,2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             8.NE.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                   NPLANIN=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IER=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        588
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BESSESSE DESCRIPTION OF PROPERTY OF PROPERTY OF SESSION OF PROPERTY OF PROPERT

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WRITE(IOVOTE,*)* IER=*, IER,* FROM BELBIN, TRIALS,SUCCESSES**, IW2(K,2),IW2(K,1),* K=*,K
W2(K,3)=0.
                                                                                                                                                                                                                                                                                                                                                                                                                  C NPTEMP=# PTS READ, NPT=# PTS NOT EXCLUDED BY USER, NP=# ANALYZED C NPFILE=PT# ON CURRENT FILE C NPAUS=PT# IN DATA BASE, IE, 1ST WORD OF RFCORD
                                                                                                                                                                                                                      IF(IDIGIT(IOUTPUT, IOMAX-2).NE.0.0R.IDIGIT(IOUTPUT, IOMAX-3)
                                                                                                                                                                                                                                                                                                                                                        WRITE(IOVOTE,*) RELIABILITY INDEX PER SET WELLE(IOVOTE,94) ID (ISETID(K),k=1,ISETMAX) WRITE(IOVOTE,93) X', (WSET(K)/TEMP,k=1,ISETMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    MPAUS=PT# IN DATA BASE, IE. 1ST WORD OF RECORD DO305 K=1,NSPAIR DO305 J=1,8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         320 READ(01.*, END=360) (BUFFER(L), L=1, INMAX)
                                                                                                                     DO 296 K=1.NSPAIR
|| |= | DSET[(|TEMPM(K,1)+1)
|| 2= | DSET[(|TEMPM(K,2)+1)
|| 2= | DSET[(|TEMPM(K,2)+1)
|| 3= | MSET[(|1)+W2(K,3)
|| WSET[(|2)+W2(K,3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 343 K=1,ISETMAX1
DO 343 J=1.5
                                                                                        DO 291 I=1, ISETMAX
291 WSET(I)=0.
                                                                                                                                                                                                                                                                       WRITE(IOVOTE,*)
                                                                                                                                                                                                                                                      TEMP=ISETMAX-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NPFILE=NPFILE+1
NPABS= BUFFER(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NPTEMP=NPTEMP+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         343 ISCORES(K,J)=0
                                                                                                                                                                                                                                       8. NE. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                        NPTEMP=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NPFILE=0
                                                                          CONTINUE
                                                                                                                                                                                                       296 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          306 NFILE=1
                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                          NPT=0
                                                                                                                                                                                                                                                                                                                                                                         0=dN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          307
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IF(NPERT.NE.O.AND.IPERT.EQ.J)TEMPER=PERTS*PERTURB(J)
TEMPV(K)=TEMPV(K)+TEMPM(K,J+4)*BUFFER(J)*(1.+TEMPER)
                                                                                                                                                                                                                              IF(NSETCOM.LE.0) GO TO 335
DO 331 K=1,NSETCOM
IF(ITEMP.EQ.ISETCOM(2*K)) ITEMP=ISETCOM(2*K-1)
                                                                                                              ITEMP-BUFFER(ISETVAR)
IF(NSETOUT.EQ 0.AND.NSETCOM.EQ.0) GO TO 335
IF(NSETOUT.LE.0) GO TO 329
IF(NSETOUT.LE.0) GO TO 329
IF(NEMP.EQ.ISETOUT(K)) GO TO 320
CONTINUE
IF(IDIGIT(10UTPUT,10MAX-1),NE.0) THEN WRITE(10VOTE,*)*
WRITE(10VOTE,*)* POINT NUMBER*,NPFILE WRITE(10VOTE,*)(BUFFER(L),L=1,1NMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          KIEIDSETI(ITEMPM(K,1)+1)
K2=LUSETI(ITEMPM(K,2)+1)
IF(LHS1.LE.RHS.AND.LHS2.LT.RHS) THEN
IVUTE(K1,1)=IVUTE(K1,1)+1
IVUTE(K2,2)=IVUTE(K2,2)+1
VOTE(K2,3)=VOTE(K1,3)+1.
VOTE(K1,4)=VOTE(K1,4)+1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (NPLANIN.NE.O) THEN DO 353 KK=1, NPLANIN IF(K.EQ.IPLANE(KK)) GO TO 354 CONTINUE
                                                                                                                                                                                                                                                                                                                                                              X0=IDSET1(ITEMD+1)
NPINSET(K0)=NPINSET(K0)+1
336 DO 340 K=1,ISETMAX
DO 341 J=1,5
341 IVOTE(K,J)=0
DU 342 J=1,5
342 VOTE(K,J)=0.
340 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TEMPV(K)=0.
DO 355 J=1,INMAX
IF(J.EQ.ISETVAR) GO TO 355
TEMPER=0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 357 I1=1, [SETMAX-1
DO 357 I2=I1+1, [SETMAX
K=K+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             LHS1=TEMPM(K,3)
LHS2=TEMPM(K,4)
RHS=TEMPV(K)
TEMP1=LHS1-RHS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TEMPO=LHS1-LHS2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        TEMP2=RHS-LHS2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    GO TO 357
                                                                                                                                                                                                                                                                                                                                NPT=NPT+1
                                                                                                                                                                                                                                                                                         331 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                   I +dN=dN
                                                                          END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END 1F
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              K = 0
                                                                                                                                                                                                                                329
                                                                                                                                                                                                                                                                                                                              335
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           354
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           355
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  353
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VOTE(R. S. 3 = VOTE(R. S. 5) = VOTE(R. S. 5)

VOTE(R. S. 5) = VOTE(R. S. 5) =
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IF(K.EQ.1) WRITE(10VOTE.\*)' HYPERPLANE VOTES FOR POINT

GO TO 357 ITEMP0=1.

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DISTANCES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 1F(IVOTE(K,5).GT.1VOTE(KMAX2,5)) KMAX2=K
1F(IVOTE(K,5).EQ.1VOTE(KMAX2,5).AND.K.NE.KMAX2)KKMAX2=1
1F(K.EQ.KMAX2)KKMAX2=0
1F(IVOTE(K,5).GT.1VOTE(KQ,5)) KOUNT2-KOUNT2+1
1F(IVOTE(K,5).LT.1VOTE(KMAX2,5)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(IVOTE(K,1).GT.IVOTE(KMAX1,1)) KMAX1=K
IF(IVOTE(K,1).EQ.IVOTE(KMAX1,1).AND.K.NE.KMAX1)KKMAX1=1
IF(K.EQ.KMAX1) KKMAX1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 351 K=1,ISETMAX
IVOTE(K,5)=IVOTE(K,1)-IVOTE(K,2)+IVOTE(K,3)+IVOTE(K,4)
                                                                                                                                                                                                                                                            IF (TEMPILE, THS. AND. TEMP2. LE.RHS) WRITE(IOVOTE, 71)

8 K. ITEMPM(K, 2), CHB1, TEMP1. TEMP2, CHB2, RHS, ITEMPM(K, 1)

IF (TEMP1. LT. RHS. AND. TEMP2. GT. RHS) WRITE(IOVOTE, 72)

8 K. ITEMPM(K, 2), CHB1, TEMP1. RHS, TEMP2. CHB2, ITEMPM(K, 1)

IF (TEMP1. EQ.RHS. AND. TEMP2. EQ. RHS) GG. TO 357

IF (TEMP1. GE.RHS. AND. TEMP2. GE.RHS) WRITE(IOVOTE, 73)

8 K. ITEMPM(K, 2), RHS, CHB1, TEMP1, TEMP2, CHB2, ITEMPM(K, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF(IVOTE(K,1).GT.IVOTE(K0,1)) KOUNTI=KOUNTI+1
IF(IVOTE(K,1).LT.IVOTE(KMAX1,1)) THEN
IF(K2MAX1.EQ.0) K2MAX1=K
IF(IVOTE(K,1).GT.IVOTE(K2MAX1,1)) K2MAX1=K
8, NP4BS, ', RECORD #', NPTEMP
IF(K.EQ.1)WRITE(IOVOTE, *)' HYPL# SETID
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF(TEMPO.NE.O.) WRITE(IOVOTE,*)
                                                                                                                                                                                                                       TEMP1=AMIN1 (LHS1, LHS2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TEMPO=FLOAT(ISETMAX-1)
                                                                                                                                                                                                                                            TEMP2=AMAX1(LHS1,LHS2)
                                                                                                                        IF (LMS1.GT.LMS2) THEN CHB1=CHRB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 356 K=1,1SETMAX
                                                  & NORMAL TO PLANES
                                                                                                                                                                      CHB2=CHLB
                                                                          CHB1=CHLB
CHB2=CHRB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          KOUNT4=0
KOUNT5=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      KKMAX1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              KKMAX2=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      KKMAX3=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              XXMAX4=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  KKMAX5=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        (OUNT 1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        40UNT3=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            K2MAX1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    K2MAX2=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            K2MAX3=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  K2MAX4=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          K2MAX5=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              KOUNT2=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       KMAX1=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               KMAX2=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     KMAX3=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           KMAX4=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                             357
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         351
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IF(IVOTE(KO.1).EQ.IVOTE(KMAX1.1)) THEN
IF(KKMAX1.EQ.0) ISCORES(1.1)=ISCORES(1.1)+1
IF(KKMAX1.EQ.0) ISCORES(2.1)=ISCORES(2.1)+1
IF(KKMAX1.EQ.0) ISCOREST(0.1.1)=ISCOREST(KO.1.1)+1
IF(KKMAX1.EQ.0) ISCOREST(KO.2.1)=ISCOREST(KO.2.1)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               END IF
If(IVOTE(K0,5) EQ.IVOTE(KMAX2,5)) THEN
IF(KKMAX2.EQ.0) ISCORES(1,2)=ISCORES(1,2)+1
IF(KKMAX2.EQ.1) ISCORES(2,2)=ISCORES(2,2)+1
IF(KKMAX2.EQ.1) ISCOREST(K0,1,2)=ISCOREST(K0,1,2)+1
IF(KKMAX2.EQ.1) ISCOREST(K0,2,2)=ISCOREST(K0,2,2)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF(KKMAX3.EQ.0) ISCORES(1,3)=ISCORES(1,3)+1
IF(KKMAX3.EQ.0) ISCORES(2,3)=ISCORES(2,3)+1
IF(KKMAX3.EQ.0) ISCOREST(K0,1,3)=ISCOREST(K0,1,3)+1
IF(KKMAX3.EQ.1) ISCOREST(K0,2,3)=ISCOREST(K0,2,3)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF(VOTE(K0.4).EQ.VOTE(KMAX4.4)) THEN

IF(KKMAX4.EQ.O) ISCORES(1,4)=ISCORES(1,4)+1

IF(KKMAX4.EQ.1) ISCORES(2,4)=ISCORES(2,4)+1

IF(KKMAX4.EQ.0) ISCOREST(K0,1,4)=ISCOREST(K0,1,4)+1

IF(KKMAX4.EQ.0) ISCOREST(K0,2,4)=ISCOREST(K0,2,4)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF(VOTE(K0.5).EQ.VOTE(KMAX5.5)) THEN
IF(KKMAX5.EQ.0) ISCORES(1.5)=ISCORES(1.5)+1
IF(KKMAX5.EQ.1) ISCORES(2.5)=ISCORES(2.5)+1
IF(KKMAXS.EQ.0) ISCOREST(R0.1.5)=ISCOREST(R0.1.5)+1
IF(KKMAX5.EQ.0) ISCOREST(R0.2.5)=ISCOREST(R0.2.5)+1
                                                                                             IF(VOTE(K,3).GT.VOTE(KMAX3,3)) KMAX3=K
IF(VOTE(K,3).EQ.VOTE(KMAX3,3).AND.K.NE.KMAX3)KKMAX3=1
IF(N.EQ.KMAX3) KKMAX3=0
IF(N.EQ.KMAX3) KT.VOTE(KQ,3)) KQUNT3=KQUNT3+1
IF(IVOTE(K,3).LT.IVOTE(KMAX3,3)) THEN
IF(IXMAX3.EQ.Q) K2MAX3=K
IF(IVOTE(K,3).GT.IVOTE(KZMAX3,3)) K2MAX3=K
END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF(VOTE(K,5).GT.VOTE(KMAX5.5)) KMAX5=K
IF(VOTE(K,5).EQ.VOTE(KMAX5,5).AND.K.NE.KMAX5)KKMAX5=1
IF(K.EQ.KMAX5) KKMAX5=0
IF(VOTE(K,5).GT.VOTE(K0.5)) KOUNTS=KOUNT5+1
IF(VOTE(K,5).LT.VOTE(KMAX5.5)) THEN
IF(KZMAX5.EQ.O) KZMAX5=K
IF(VOTE(K,5).GT.VOTE(KZMAX5.5)) KZMAX5=K
                                                                                                                                                                                                                                                                                                                                                                                        IF(VOTE(K,4).GT.VOTE(KMAX4,4)) KMAX4=K
IF(YOTE(K,4).EQ.VOTE(KMAX4,4).AND.K.NE.KMAX4)KKMAX4=1
IF(Y.EQ.KMAX4) KKMAX4=0
IF(VOTE(K,4).GT.VOTE(KQ,4)) KQUNT4=KQUNT4+1
IF(XOTE(K,4).LT.VOTE(KMAX4,4)) THEN
IF(KZMAX4.EQ.Q) KZMAX4=K
IF(VOTE(K,4).GT.VOTE(KZMAX4.4)) KZMAX4=K
IF(K2MAX2.EQ.U) K2MAX2=K
IF(IVOTE(K,5).GT.IVOTE(K2MAX2,5)) K2MAX2=K
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        (KOUNT1.GT.0) THEN
ISCORES(KOUNT1+2.1)=ISCORES(KOUNT1+2.1)+
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF(VOTE(KO.3).EQ.VOTE(KMAX3.3)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  1F (KOUNT 1.GT.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    356
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If(vote(k0,5).eq.vote(kMax5,5)) ITEMp3=1
If(ITEMP1.eq.1) THEN
   If(ITEMP2.eq.1.AND.ITEMP3.eq.1) ISCOREBP(1)=ISCOREBP(1)+1
   If(ITEMP2.eq.0.OR.ITEMP3.eq.0) ISCOREBP(2)=ISCOREBP(2)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF(ITEMP1.EQ.0) THEN
IF(ITEMP2.EQ.1.AND.ITEMP3.EQ.0) ISCGEEG=(3)=ISCOREBP(3)+1
IF(ITEMP2.EQ.0.AND.ITEMP3.EQ.1) ISCOREBP(4)=ISCOREBP(4)+1
IF(ITEMP2.EQ.0.AND.ITEMP3.EQ.0) ISCOREBP(5)=ISCOREBP(5)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            "MAX4,5).EQ
ISCOREST(KU.KOUNT1+2,1)=ISCOREST(KO.FOUNT1+2,1)+1
                                                                           ISCORES(KOUNT2+2,2)=ISCORES(KOUNT2+2,2)+1
ISCOREST(KO, FOUNT2+2,2)=ISCOREST(KG, KOUNT2+2,2)+1
                                                                                                                                                       1F(MOUNT3.G1.0) THEN
1SCORES(KOUNT3+2,3)+1
1SCUREST(K0,KOUNT3+2,3)+1
1SCUREST(K0,KOUNT3+2,3)+1
                                                                                                                                                                                                                                                                                                                                                                       IF(KOUNT5.GT.0) THEN
ISCORES(KOUNT5+2.5)=ISCORES(KOUNT5+2.5)+1
ISCOREST(KO.KOUNT5+2.5)=ISCOREST(KG.*?@475+2.5)+1
                                                                                                                                                                                                                                                                                            ISCORES(KOUNT4+2,4)=ISCORES(KOUNT4+2,4)+1
ISCOREST(KO,KOUNT4+2,4)=ISCOREST(KO,KOUNT4+2,4)+1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF(IDIGIT(10UTPUT,10MAX-2),NE.O) THEN
IF(IPERT,GT.O.AND.PERTS.EQ.-1.) WRITE(1G.OTE.*)

+ PERTURBATION OF VARIABLE IPERT
IF(IPERT,GT.O.AND.PERTS.EQ.+1.) WRITE(1D.OTE.*)

- PERTURBATION OF VARIABLE IPERT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    !F(VOTE(KMAX4,4).EQ.VOTE(KMAX5,4).ANC ..TE
&JOTE(KMAX5,5)) ITEMP1=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF(VOTE(KO,4).EQ.VOTE(KMAX4,4)) ITEMP2=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ITEMP1=6+3*MINO(KOUNT4,2)+MINO(KOUNT5,2)
ISCOREBP(ITEMP1)=ISCOREBP(ITEMP1)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF(IVUTE(K,1).EQ.ITEMP1) ITEMP2=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 358 K=ITEMPO+1, ISETMAX
IF(IVOTE(K,1), GT. ITEMP1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ITEMP1=IVOTE(ITEMPO.1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ITEMP1=IVOTE(ITEMPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ASSIGN 371 TO IRETURN
                                                     IF (KOUNT2.GT.O) THEN
                                                                                                                                                                                                                                                                      IF (KOUNTA.GT.O) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 GO TO 358
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     I TEMPO=K
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ITEMP2=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IN-ITEMPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ITEMP2=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ITEMP2=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ITEMP1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ITEMP3=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ITEMP0=1
                                                                                                                                                                                                                                        END IF
                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                             END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             358
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GO TO 400

IF(IDIGIT(IOUTPUT,IOMAx-2).NE.0)

WHITE(IOVOTE,81)CHBL,ITEMP,1SETIO(K),

IVOTE(K,1),CH1,(IVOTE(K,J),J=2,5).CH2,(VOTE(K,J),J=1,3)

CH3,VOTE(K,4),CH4,VOTE(K,5),CH5

IF(K,E0,K0) ITEMP3=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        379 WRITE(10VOTE,82)CHBL,CHBL,ISETID(K),
81VOTE(K,1),CH1,(IVOTE(K,J),J=2,5),CH2,(VOTE(K,J),J=1,3)
8,CH3,VOTE(K,4),CH4,VOTE(K,5),CH5
380 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     B IF(IDIGIT(IOUTPUT, IOMAx-2).NE.0)
&WRITE(IOVOTE.81)CHBL.ITEMP,ITEMP,IVOTE(KO,1),CH1,
&(IVOTE(KO,J),J=2,5).CH2,(VOTE(KO,J),J=1,3),CH3,
&VOTE(KO,A),CH4,VOTE(KO,5).CH5
371 IF (IDEGIT (IDEDITOR) | 1.NE.U)

8WRITE(IOVOTE.80.)NPABS.11EMP.1SETID(11EMPU),

8LVOTE(ITEMPU,1)...H1.(IVUTE(ITEMPU,J).J-2,5),CH2.

8.VOTE(ITEMPU,J).J-1,3).CH3.VOTE(ITEMPU,4),CH4

8.VOTE(ITEMPU,J).J-1,3).CH3.VOTE(ITEMPU,4),CH4

IF (ITEMPU.EQ.U).J-1,3).CH3.VOTE(ITEMPU,4),CH4

IF (ITEMPU.EQ.U).J-1,3).CH3.VOTE(ITEMPU,J).CH4

IF (ITEMPU.EQ.U).J-1,3).CH3.VOTE(ITEMPU.H1).THEN

IF (ITEMPU.EQ.U).J-1,1SETMAX

IF (IVOTE(K.1).EQ.ITEMPI).THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 380 K=1, ISETMAX
IF(IVOTE(K,1), EQ. I : EMP1. OR. K. EQ. KO) GO TO 380
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       381 IF(IDIGIT(IOUTPUT,IOMAX-5).EQ.0) G) TO 389 K3=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TO 381
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         375 IF(IDIGIT(IOUTPUT,IOMAX-2).EQ.0) GO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 377 J=1.5
IF (IVOTE(K,J).NE.D) GO TO 379
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               379
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               10
                                                                                                                                                                                                                                                                                                                                                                                                                                         359 CONTINUE
370 IF(ITEMP3.NE.U) GC TO 375
IF(KO.GT.ISETMAX) GC TO 375
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 378 J=1,4
1F(VOTE(K,J).NE.0.) GO
CONTINUE
                                                                                                                                                                                                                                                ASSIGN 372 TO IRETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     (NPLANIN, NE. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ASSIGN 373 TO IRETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ASSIGN 374 TO IRETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 KB=0
DO 383 K=1, ISETMAX
IB=2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            60 TO 380
END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     GO TO 400
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 GO TO 400
                                                                                                                                                                                                                            1 スニス
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IK=KO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    W6=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           K7=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        X4=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       373
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IF(K6.EQ.0.AND.K5.EQ.0.AND.K4.EQ.0.AND.K7.NE.0)
IDCHOICE(K7.9,K0)=IDCHOICE(K7.9,K0)+1
IF(K5.NE.0) IDCHOICE(K5.10,K0)=IDCHOICE(K5.10,K0)+1
IF(K5.NE.0) IDCHOICE(K5.11,K0)=IDCHOICE(K5.11,K0)+1
IF(K5.NE.0) IDCHOICE(K5.11,K0)=IDCHOICE(K5.11,K0)+1
IF(K5.EQ.0.AND.K8.NE.0)IDCHOICE(K8.11,K0)=IDCHOICE(K8.11,K0)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF(K5.NE.0) IDCHOICE(K5.7,K0)=IDCHOICE(K5.7,K0)+1
IF(K5.EQ.0.AND.K6.NE.0)IDCHOICE(K6.7,K0)=IDCHOICE(K6.7,K0)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (KS.EQ.O.AND.K6.EQ.O.AND.K4.EQ.O.AND.K7.NE.O)
IDCHOICE(K7,8,K0)=IDCHOICE(K7,8,K0)+1
IF (K6.NE.O) IDCHOICE(K6.9,K0)=IDCHOICE(K6.9,K0)+1
IF (K6.EQ.O.AND.K5.NE.O.IDCHOICE(K5,9,K0)=IDCHOICE(K5,9,K0)+1
IF (K6.EQ.O.AND.K5.EQ.O.AND.K4.NE.U)IDCHOICE(K4,9,K0)=
IDCHOICE(K4,9,K0)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    1F(K5.NE.U) IDCHOICE(K5,8,K0)=IDCHOICE(K5,8,K0)+1
IF(K5.EQ.O.AND.K6.NE.O)IDCHOICE(K6,8,K0)=IDCHOICE(K6,8,K0)+1
IF(K5.EQ.O.AND.K6.EQ.O.AND.K4.NE.O)IDCHOICE(K4,8,K0)=
IDCHOICE(K4,8,K0)+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IDCHOICE(K,4,1SETMAX1) = IDCHOICE(K,4,1SETMAX1)+1
IDCHOICE(K,5,1SETMAX1) = IDCHOICE(K,5,1SETMAX1)+1
IF(1B.NE.2.AND.IP.NE.2)IDCHOICE(K,4,K0) = IDCHOICE(K,4,K0)+1
IF(1B.NE.2.OR.IP.NE.2)IDCHOICE(K,5,K0) = IDCHOICE(K,5,K0)+1
                                                                                 .VOTE(KMAX4,4)) 18=0
.VOTE(K2MAX4,4) AND.K2MAX4.NE.0) 18=1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF(k4.GT.0)IDCH0ICE(k4,6,K0)=IDCH0ICE(k4,6,K0)+1
IF(k4.NE.0)IDCH0ICE(k4,7,K0)=IDCH0ICE(k4,7,K0)+1
IF(k4.EQ.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                    IF(1B.EQ.0)IDCHOICE(K,2.KO)=IDCHOICE(K,2.KO)+1
IF(1P.EQ.0)IDCHOICE(K,3.KO)=IDCHOICE(K,3.KO)+1
IF(K.EQ.KO) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  33 401 I=IPERT+1, INMAX
I*(PERTURB(I).EQ.0) GO TO 401
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  X4=X
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            K5=K
K6=K
K7=K
K8=K
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(PERTS.GT.0.) GO TO 336
IF(IPERT.EQ.INMAX) GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (IB. EQ. 0. AND. IP. EQ. 0) K;
IF (IB. EQ. 1. AND. IP. EQ. 1) K;
IF (IB. EQ. 0. AND. IP. EQ. 1) K;
IF (IP. EQ. 0. AND. X7. EQ. 0) K;
IF (IP. EQ. 0. AND. X7. EQ. 0) K;
IF (IP. EQ. 0. AND. X8. EQ. 0) K;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       389 IF (NPERT. EQ. 0) GO TO 320
LF(VOTE(K,4).EQ.
IF(VOTE(K,4).EQ.
IP=2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       1F (K3.EQ.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PERTS = - PERTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          383
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IF(IDIGIT(IOUTPUT,IOMAX-3).EQ.0) GO TO 410
WRITE(IOVOTE,*)
WRITE(IOVOTE,*)
WRITE(IOVOTE,*)
WRITE(IOVOTE,*)
VOTES
WRITE(IOVOTE,*)
VOTES
WRITE(IOVOTE,9)
WRITE(IOVOTE,92)0,(ISCOREST(K,1,4)+ISCOREST(K,2,4),K=1,ISETMAX)
WRITE(IOVOTE,92)0,(ISCOREST(K,1,4)+ISCOREST(K,2,4),K=1,ISETMAX)
WRITE(IOVOTE,92)1-2,(ISCOREST(K,1,4),K=1,ISETMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE(10V0TE;*)' DISCRIMINATION SUCCESS BV SET, USING P VOTES'
WRITE(10V0TE;*)' SETS >
SET 1D'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 391 I=1,ISETMAX1
ISCOREST(K,ISETMAX2,4)=ISCOREST(K,I,4)+ISCOREST(K,ISETMAX2,4)
WRITE(10V0TE,91)' TOTAL',(ISCOREST(K,ISETMAX2,4),K=1,ISETMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE(10VOTE,88)' UNIQUE 1ST PLACE',(ISCORES(1,J),J=1,S)
WRITE(10VOTE,88)' TIED 1ST PLACE',(ISCORES(2,J),J=1,S)
DO 361 K=3.ISETMAX1
WRITE(10VOTE,89)K-2.' WITH > VOTES',(ISCORES(K,J),J=1,S)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        360 IF(IDIGIT(IOUTPUT,IOMAX-3),EQ.0) GO TO 363
WRITE(IOVOTE,*)''
WRITE(IOVOTE,*)''
WRITE(IOVOTE,*)''
WRITE(IOVOTE,*)''
WRITE(IOVOTE,*)''
** BVOTE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CH4=CHBL1
CH5=CHBL1
CH5=CHBL1
CH5=CHBL1
IF(IVOTE(IK, 1), GE.IVOTE(KMAX2, 5), CH2=CHASK
IF(IVOTE(IK, 3), GE.IVOTE(KMAX3, 3), CH3=CHASK
IF(VOTE(IK, 3), GE.VOTE(KMAX4, 4)), CH3=CHASK
IF(VOTE(IK, 4), GE.VOTE(KMAX4, 4)), CH4=CHASK
IF(VOTE(IK, 5), GE.VOTE(KMAX5, 5)), CH5=CHASK
GO TO IRETURN.(371, 372, 373, 374)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CLOSE(07,STATUS='KEEP')
IF(IOVOTE.EQ.08) CLOSE(08,STATUS='KEEP')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 NFILE=NFILE+1
CALL ATFILE(FILIN.NFILE)
IF(NFILE.NE.0) GO TO 310
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         391 K=1, ISETMAX
                                                                                                                                                                                                                                                                                                                                                          CH1=CHBL1
CH2=CHBL1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CH3=CHBL
                                                            CONTINUE
GO TO 320
GO TO 336
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             361 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    8
                                                            401
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IF(K.EQ.1)WRITE(10V5TE.*) CHOOSE SET WITH B1=P1, ELSE NO CHOICE' IF(K.EQ.2)WRITE(10V0TE.*) CHOOSE SET WITH B1' F(K.EQ.3)WRITE(10V0TE.*) CHOOSE SET WITH P1' FIKEQ.3)WRITE(10V0TE.*) CHOOSE SETS WITH B1 OR B2)B(P1 OR P2)' FK(K.EQ.5)WRITE(10V0TE.*) CHOOSE SETS WITH B1 OR B2 OR P1 OR P2' IF(K.EQ.5)WRITE(10V0TE.*) CHOOSE SETS WITH B1 ELSE WITH B2=P2
                                                                                                                                                                                                                                DESCRIMINATION SUCCESS USING B & P VOTES JOINTLY B & B AGREE, ON IDENTIFIED SET', ISCOREBP(1)
B NOT P SELECTS IDENTIFIED SET', ISCOREBP(3)
P & B DISAGREE, ON OTHER SET', ISCOREBP(5)
B & P AGREE, ON OTHER SET', ISCOREBP(5)
B & DISAGREE, ON ONE OTHER SET', ISCOREBP(5)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        OTHER=
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE(10VÓTE,*) TER= TER, FROM BELBIN. TRIALS, SUCCESSES= TIDCHOICE(I,K,1SETWAXI), IOCHOICE(I,K,I)
                      00 397 K=1,1SETM4.
00 397 I=1,1SETM4.*
397 ISCOREST(K,ISETM4.1.5)=ISCOREST(K,I,5)+ISCOREST(K,ISETMAX2,5)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF(W.EQ.4.0R.K.EQ.5) GO TO 393
DO 395 J=1.ISETMAX
IDCHOICE(I,K,ISETMAX1) = IDCHOICE(I,K,ISETMAX1) + IDCHOICE(I,K,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     & ELSE B2=P1, ELSE B1=P2, ELSE NO CHOICE
IF(K.EQ.B)WRITE(IOvOTE.*) CHOOSE SET WITH B1=P1, ELSE B2=P1,
& ELSE B1=P2, ELSE B2=P2, ELSE P1'
                                                                                                                                              TITAL (ISCOREST(K, ISETMAX2, 4), K=1, ISETMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CHOOSE SET WITH BI=PI, ELSE B2=P2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(IDCHOICE(I,K.ISETMAXI).EQ.0) GO TO 392
CALL BELBIN(IDCHOICE(I,K.ISETMAXI),IDCHOICE(I,K.I),ALPHA
8,PHAT,PLOWER,PUPPER,IER)
IF(IER.NE.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       OTHER', (ISCOREBP(5+3*2+J), J=1,3)
                                                                                                                                                                                                                                                                 WRITE(10V0TE,*) P & 9 AGREE, ON IDENTIFIED SETTING WRITE(10V0TE,*) P NOT P SELECTS IDENTIFIED SETTING WRITE(10V0TE,*) P NOT B SELECTS IDENTIFIED SETTING WRITE(10V0TE,*) P & 9 DISAGREE, ON ONE OTHER SETTING WRITE(10V0TE,*) B & P AGREE, ON ONE OTHER SETTING WRITE(10V0TE,*) B & P VOTE RANK OF IDENTIFIED SETTING WRITE(10V0TE,*) B & P VOTE RANK OF IDENTIFIED SETTING WRITE(10V0TE,*) B & P VOTE RANK OF IDENTIFIED SETTING WRITE(10V0TE,*) B & P VOTE RANK OF IDENTIFIED SETTING WRITE(10V0TE,*) BRANK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RULES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 398 I=1,2
WRITE(IOVOTE,*) I,(:SCOREBP(5+3*(I-1)+J),J=1,3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            SUCCESS OF SEVERAL CHOICE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF(IDIGIT(IOUTPUT.:SMAX-5).EQ.0) GO TO 414 WRITE(IOVOTE,*)*
WRITE(IOVOTE,*)*
DO 399 K±1,ICH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  395 CONTINUE
393 ITEMP1=ITEMP1+IDCH0ICE(I.K.I)
ITEMP2=ITEMP2+IDCH0ICE(I.K.ISETMAXI)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      XDCHOICE(I,K,ISETMA×1)=PLOWER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          8, ELSE NO CHOICE'
IF (K.EQ.7)WRITE(10.07E.*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DU 394 I=1. ISETMAX
                                                                                                                                                 WRITE(10VOTE,91)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(IOVOTE,*)
                                                                                                                                                                                                                                        WRITE ( IOVOTE, *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             392 XDCHUILL
394 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ITEMP1=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ITEMP2=0
CONTINUE
387
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                410
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           399
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SET
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&(ISCOREP(K,J),J=1,4),TEMP1,(ISCOREP(K,J),J=5,8),TEMP2
IF(ITEMP1.NE.O.ANO.ITEMP2.EQ.O) wRITE(IOVOTE,86) K,ITEMPM(K,1)
&.ITEMPM(K,2),(ISCOREP(K,J),J=1,4),TEMP1
IF(ITEMP1.EQ.O.ANO.ITEMP2.NE.O) WRITE(IOVOTE,87) K,ITEMPM(K,1)
&.ITEMPM(K,2),(ISCOREP(K,J),J=5,8),TEMP2
                      & ELSE B2=P1, ELSE B2=P2, ELSE P1, ELSE P1, ELSE B1=P2, IF(K.EQ.10)WRITE(IOVOTE.+) CHOOSE SET WITH B1=P1, ELSE B1=P2, 8 ELSE NO CHOICE (IOVOTE,+) CHOOSE SET WITH B1=P1, ELSE B1=P2, 8 ELSE B1:
IF(K.EQ.9)WRITE(IOVOTE,*) CHOOSE SET WITH B1=P1, ELSE B1=P2,
                                                                                                                                                                                                                                               WRITE(IOVOTE,96)' CHOICE' (ISETID(J), J=1, ISETMAX),' SUCCESS'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ITEMP2=ISCOREP(K,5)+ISCOREP(K,6)+ISCOREP(K,7)+ISCOREP(K,8)
IF(ITEMP2.NE.0)TEMP2=FLOAT(ISCOREP(K,5))/FLOAT(ITEMP2)*100
IF(ITEMP1.NE.0.AND.ITEMP2.NE.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ITEMP!=ISCOREP(K,1)+ISCOREP(K,2)+ISCOREP(K,3)+ISCOREP(K,4)
IF(ITEMP!.NE.0)TEMP!=FLOAT(ISCOREP(K,1))/FLOAT(ITEMP!)*100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 415 K=1,NSPAIR
WRITE(IOVOTE,*)K,ITEMPM(K,1),W1(K,3),ITEMPM(K,2),W2(K,3)
                                                                                                                                                                                                                                                                                                                                                                                  CALL BELBIN(ITEMP2, TEMP1, ALPHA, PHAT, PLOWER, PUPPER, IER)
WRITE(IOVOTE, 98) ITAMP1, SUCCESSES IN .ITEMP2, TRIALS.
&, PLOWER, 'TO', PUPPER, 'PROB SUCCESS'
399 CONTINUE
                                                                                                                                                                                                                                                                      DO 396 I=1,1SETMAX
WRITE(10V0TE,95)ISETID(1),(IDCHOICE(1,K,J),J=1,ISETMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE(10VOTE,*) DISCRIMINATION SUCCESS BV HVPERPLANE WRITE(10VOTE,*) HVPERPLANE POINTS IN THE FIRST SET POINTS IN THE SECOND SET
                                                                                                                                                                                      ACTUAL ID
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE(IOVOTE,*)' #SET! SET2 VVOTE NVOTE OVOTE GVOTE 8 VVOTE NVOTE OVOTE GVOTE V%T'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       9000 WRITE(IOVOTE,*)''
CALL PTIME(TIMEOUT)
CALL DATIM(DATE1,TIME1)
WRITE(IOVOTE,9010)(TIMEOUT-TIMEIN)*3600.,TIME1
9010 FORMAT(' TIME USED:',FB.2,' SECONDS, COMPLETED AT'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  REL INDEX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        414 IF(IDIGIT(IOUTPUT, IOMAX-4).EQ.0) GO TO 9000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SET#1
                                                                                                                                                                                                                L PROB'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     PLANE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                K1=1DSET1(1TEMPM(K,1)+1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            K2=IDSETI(ITEMPM(K.2)+1)
                                                                                                                                                                                                                                                                                                                                       &, XDCHOICE(I, K. ISETMAXI)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 385 I2=I1+1, ISETMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          C TERMINATING RUN PROCEDURE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 385 II=1, ISETMAX-1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE(10VOTE, *)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE(IOVOTE,*)
                                                                                                                                                                                   WRITE(10V0TE, +)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(IOVOTE, *)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    REL INDEX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       415 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             385 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                    396 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            TEMP1=-1
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&F6.2, HOURS')

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ò
                                                                                                                        9170 WRITE(IOVOTE,*) ENTER U.1 AS THERE ARENT,ARE MORE CASESTREAD(US,*)ICASE

IF(IMODE.EQ.0)WRITE(IOVOTE,*)ICASE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CATFILEnnunnunnunnun sanan sanan
                                                                                                                                                                   C RETURNS IX WITH 0 FOR ALL BUT ITH DIGIT. IDIGIT(5876,3)=800.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 SUBROUTINE ATFILE (FILIN, I)
C SETS UP FILIN(I) AS FILE 01. IF FILIN(I) IS 0, RETURNS I=0.
CHARACTER *64FILIN(I), FILECR
                                                                                                                                                                                                                            IDIGIT=MOD(IX,11)
IF(I.GT.0) IDIGIT=IDIGIT-MOD(IX,12)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       10 IF(FILIN(I).NE.FILECR) GO TO 20 IF(I.LE.1) REWIND 01
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 HIS/SINGLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        BELBIN
                                           WRITE(IOVOTE, 140)
GO TO (9180,130), ICASE+1
STOP
                                                                                                                                                                                                                                                                                                                IF(X.LT.-60.) EXP0=0.
IF(X.GE.-60.) EXP0=EXP(X)
RETURN
                                                                                                                                                    FUNCTION IDIGIT(IX, I)
                                                                                                                                                                                                                                                                                                                                                                             FUNCTION ALOGO(X)
IF(X)10,20,10
10 ALOGO=ALOG(X)
                                                                                                                                                                                                                                                                                                      FUNCTION EXPO(X)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IMSL ROUTINE NAME
                                                                                                                                                                                                             12=ITEN**(1-1)
                                                                                                                                                                                                                                                                                                                                                                                                                                        20 ALOGO=-60.
GO TO 30
30 RETURN
                                                                                                                                                                                                I 1 = I TEN * * I
                                                                                                                                                                                                                                                                                                                                                                                                                             GO TO 30
                                                                                                                                                                                  ITEN=10
                                                                                                                                                                                                                                                           RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 COMPUTER
                                                                                                                                                                                                                                                                          END
                                                                                                                                                                                                                                                                                                                                                                  ENO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END
                                                                                                                                                                                                                                                                                       --Odxav
                                                                           9180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ن ن ٺ ن د
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NTRIAL - INPUT NUMBER OF BERNOULLI TRIALS.

NX
- INPUT NUMBER OF SUCCESSES IN THE NTRIAL TRIALS

ALPHA - INPUT VALUE IN THE EXCLUSIVE INTERVAL (0.1)

USED FOR COMPUTING A 100(1-ALPHA) PERCENT

COMFIDENCE INTERVAL FOR PARAMETER P, THE

PROBABILITY OF A SUCCESS ON ANY ONE TRIAL.

PLOWER - OUTPUT LOWER CONFIDENCE LIMIT FOR P.

PLOWER - OUTPUT UPPER CONFIDENCE LIMIT FOR P.

IER - ERROR PARAMETER. (OUTPUT) H32/MDBETA, MDBETI, MLGAMD=DLGAMA, UERTST, UGETIO
 H36, H4B, H60/MDBETA, MDBETI, MLGAMA \*ALGAMA,
 UERTST, UGETIO IMSL WARRANTS ONLY THAT IMSL TESTING HAS BEEN APPLIED TO THIS CODE. NO OTHER WARRANTY, EXPRESSED OR IMPLIED, IS APPLICABLE. IERRIO INDICATES NTRIAL IS LESS THAN I.
IERRIO INDICATES NX IS EITHER NEGATIVE OR
IT EXCEEDS NTRIAL.
IT EXCEEDS NTRIAL.
IERRIOI INDICATES ALPHA IS NOT IN THE
EXCLOSIVE INTERVAL (0,1).
IERRIOZINDICATES THAT A TERMINAL ERROR
OCCURRED IN IMSL ROUTINE MOBETI. INFORMATION ON SPECIAL NOTATION AND CONVENTIONS IS AVAILABLE IN THE MANUAL INTRODUCTION OR THROUGH IMSL ROUTINE UHELP INTERVAL ESTIMATE OF THE PARAMETER P OF THE BINOMIAL DISTRIBUTION NTRIAL) GO TO 10 TERMINAL ERROR - NX IS NEGATIVE OR NX IS GREATER THAN NTRIAL CALL BELBIN (NTRIAL, NX, ALPHA, PHAT, PLOWER TERMINAL ERROR - NTRIAL IS LESS 1978 BY IMSL, INC. ALL RIGHTS RESERVED SUBROUTINE BELBIN (NTRIAL, NX, ALPHA, PHAT, PLOWER, PUPPER, 1ER) FIRST EXECUTABLE STATEMENT JANUARY 1, 1978 THAN 1 TERMINAL ERROR PUPPER, IER) - SINGLE/ALL . AND. NX .LE. S 1) 60 10 REQD. IMSL ROUTINES PRECISION/MARUWARE . GE 0 LATEST REVISION IER = 129 GO TO 9000 IF (NX .GE. IER = 0 IF(NTRIAL IER = 130 GO TO 9000 ARGUMENTS COPYRIGHT NOIATION WARRANTY PURPOSE USAGE

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- VALUE TO WHICH FUNCTION IS TO BE INTEGRATED.

X MUST BE IN RANGE (0,1) INCLUSIVE.(INDUT)

- INPUT (1ST) PARAMETER (MUST BE GREATER THAN 0)

- INPUT (2ND) PARAMETER (MUST BE GREATER THAN 0)

- OUTPUT PROBABILITY THAT A RANDOM VARIABLE
FROM A BETA DISTRIBUTION HAVING PARAMETERS

A AND B WILL BE LESS THAN OR EQUAL TO X.

- ERROR PARAMETER. (OUTPUT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IER = 129 INDICATES X 1S NOT IN RANGE (0.1)
INCLUSIVE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IER = 130 INDICATES A AND/OR B LESS THAN OR EQUAL TO 0
10 IF(ALPHA GI. U.U. AND. ALPHA LI. I.U) GO TO 15
TERMINAL ERROR - ALPHA IS OUT OF
RANGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             INFORMATION ON SPECIAL NOTATION AND CONVENTIONS IS AVAILABLE IN THE MANUAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ROUTINES - H32/MLGAMD=DLGAMA,UERTST,UGETIO
- H36.H48.H60/MLGAMA=ALGAMA,UERTST,UGETIO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 BETA PROBABILITY DISTRIBUTION FUNCTION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL MDBETA (X,A,B,P,1ER)
                                                                                                                                                                        AL = .5*ALPHA

IF (x .LE. 0.0) GO TO 20
CALL MOBETI(AL.x,RNMX+1.,PLOWER,JER)
IF(JER .NE. 0) GO TO 35
                                                                                                                                                                                                                                                                                        IF(X GE.RN) GO TO 30
CALL MDBETI(AL,RNMX,X+1.,PUPPER,JER)
IF(JER .NE. 0) GO TO 35
PUPPER = 1.-PUPPER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  TERMINAL ERROR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               JULY 1, 1983
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        HIS/SINGLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                - SINGLE/ALL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             - MDBETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL UERTST(IER, GHBELBIN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PRECISION/HARDWARE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IMSL ROUTINE NAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IER
                                                                                                                                                                                                                                                                                                                                                                   GO TO 9005
PUPPER = 1.0
GO TO 9005
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           LATEST REVISION
                                                                                                                                                                                                                                                                        PLOWER = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  < 00 a
                                                                                                                                       RNMX = RN-X
PHAT = X/RN
                                                                                                 RN = NTRIAL
                                                              IER = 131
GO TO 9300
                                                                                                                                                                                                                                                                                                                                                                                                                            35 IER = 132
                                                                                                                                                                                                                                                     GO TO 25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  REOD. IMSL
                                                                                                                                                                                                                                                                                                                                                                                                                                               9000 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ARGUMENTS
                                                                                                                     XZ
"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    9005 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    COMPUTER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NOTATION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PURPUSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    USAGE
                                                                                                 5
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- IMSL WARRANTS ONLY THAT IMSL TESTING HAS BEEN APPLIED TO THIS CODE. NO OTHER WARRANTY, EXPRESSED OR IMPLIED, IS APPLICABLE.
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INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SPECIFICATIONS FOR LOCAL VARIABLES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      AA, BB, TEMP
PS, PX, Y, P1, DA, XINT, CNT, WH, XB, DB, C, EPS, EPS1,
ALEPS, TOT, PQ, D4, ONE, ZERO
INT1, IB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NATURAL LOG OF EPSI
ALEPS/-87,49823D0/
ONE/1.0D0/,ZERO/0.0D0/
CHECK RANGES OF THE ARGUMENTS
FIRST EXECUTABLE STATEMENT
                                                                                      - 1978 BY IMSL, INC. ALL RIGHTS RESERVED.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      _:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               SPECIFICATIONS FOR ARGUMENTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             20 IF (X .ME. 0. .AND. X .NE. 1.) GO TO 25
SPECIAL CASE - X IS 0. OR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SMALLEST POSITIVE NUMBER SAFELY REPRESENTABLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 MACHINE PRECISION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                .GE. 0.0)) GO TO S
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       .GT. 0.0)) GO TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SUBROUTINE MOBETA (X, A, B, P, IER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       EPS1/1.D-38/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            EPS/1.0-7/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           25 TEMP = AINT(6d)
PS = 8B-TEMP
TF (8B .EQ. TEMP) PS = ONE
CA = AA
CB = BB
PX = DA*DLOG(Y)
C4 = DLOG(DA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               X, A, B, P
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF ((X .LE. 1.0) .AND. (X .ieR = 129 and 0 and 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             5
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IF (X .GT. 0.5) GO TO

INTI = 0

GO TO 20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DOUBLE PRECISION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  30 TO 9000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      BG = TEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Y = ONE-Y
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             P = 0.E0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    15 INT1 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        GO TO 60
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 INTEGER
                                                                                               COPYRIGHT
                                                                                                                                                                                      AARRANTY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ×
"
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DATAC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CATA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CATA
```

```
CNT WILL EQUAL DEXP(TEMP)+(1.00-PS)I+
P+V++1/FACTORIAL(I)
                                                                                                                                        FIRST TERM OF A DECREASING SERIES WILL UNDERFLOW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WH = DB
WH = WH-ONE
IF (WH .LE. ZERO) GO TO 55
PX = (PS+C)/(DA+WH)
IF (PX .GT. ONE) GO TO 45
IF (CNT/EPS .LE. TOT .OR. CNT .LE. EPS1/PX) GO TO 55
CNT = CNT*PX
IF (CNT LE. O'E) GO TO 50
                                                                             <u>-</u>
PQ - ALGAMA(AA+BB)
P1 = ALGAMA(AA)
C = ALGAMA(BB)
TEMP = SNGL(PS)
XB = PX + ALGAMA(TEMP+AA) - ALGAMA(TEMP) - D4
                                                                                                                                                                                                                                                                                                                                                                    TOT = ZEHU

IF (DB .LE. ONE) GO TO 55

XB = PX+DB+DLOG(ONE-Y)+PQ-P1-DLOG(DB)-C

SCALING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          RESCALE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (TEMP .EQ. 0.0EU) TOT = TOT+CNT GO TO 40 55 P = TOT+XINT 60 IF (INT. .NE. n) P = 1.-P 60 TO 9005 9000 CONTINUE
                                                                                                                                                                                                                                                                              XB = CNT*(WH-PS)*Y/WH
XB = CNT*(DA+WH)
XINT = XINT+XB
IF (XB/EFS GI XINT) 50 TO 30
XINT = XINT * 1 D-10
                                                                                                                                                                                                                                                                                                                                                                                                                                                               - U.0EO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   - HIS/SINGLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    - MDBETI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL UERTST(IER, CHMDBETA)
                                                                                                                                                                                                                                                                                                                                                                                                                             TEMP = XB/ALEPS

TEMP : AINT(TEMP)

IF(TEMP.LT.0.0E0) TEMP -

C = ONE/(ONE-Y)

PS = TEMP

CNT = DEXP(XB-PS*ALEPS)
                                                                                                                                                                      IF (IB .NE. 0) GO TO 35
XINT = DEXP(XB) * 1.D10
CNT = XINT*DA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        TEMP = TEMP = 1,0E0
CNT = CNT*EPS1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IMSL ROUTINE NAME
                                                                                                        IB = XB/ALEPS
XINT = ZERO
                                                                                                                                                                                                                                                     WH = ZERO
WH = WH+ONE
                                                                                                                                                                                                                                                                                                                                                                TOT = ZERO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PS - DB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    9005 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 COMPUTER
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- INPUT FIRST PARAMETER OF THE BETA DISTRIBUTION - INPUT SECOND PARAMETER OF THE BETA DISTRI-
                                                 - INVERSE BETA PROBABILITY DISTRIBUTION FUNCTION
                                                                                                                                                                                                                                                                               OUTPUT VALUE SUCH THAT P IS THE PROBABILITY THAT A RANDOM VARIABLE DISTRIBUTED BETA(A,B) IS LESS THAN OR EQUAL TO X.
ERROR PARAMETER. (OUTPUT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IMSL WARRANTS ONLY THAT IMSL TESTING HAS BEEN APPLIED TO THIS CODE. NO OTHER WARRANTY, EXPRESSED OR IMPLIED, IS APPLICABLE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IER = 131 INDICATES THAT THE VALUE X COULD NOT BE FOUND WITHIN 100 ITERATIONS OF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      - INFORMATION ON SPECIAL NOTATION AND
CONVENTIONS IS AVAILABLE IN THE MANUAL
INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
                                                                                                                                                                                                                                                                                                                                                                                                           IER = 129 INDICATES THAT P WAS NOT IN THE EXCLUSIVE RANGE (0,1).
IER = 130 INDICATES A AND/OR B LESS THAN
                                                                                                                                                        - INPUT PROBABILITY IN THE EXCLUSIVE RANGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  REQD. IMSL ROUTINES - H32/MDBETA,MLGAMD=DLGAMA,UERTST,UGETIO - H36.H48,H60/MDBETA,MLGAMA=ALGAMA,UERTST
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    1978 BY IMSL, INC. ALL RIGHTS RESERVED
                                                                                                 - CALL MDBETI (P.A.B.X, IER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NEWTONS METHOD.
                                                                                                                                                                                                                                                                                                                                                                                     TERMINAL ERROR
  - JUNE 1, 1980
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     - SINGLE/ALL
                                                                                                                                                                                                                                                         BUTION
                                                                                                                                                                                  (0, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PRECISION/HARDWARE
                                                                                                                                                                                                                                                                                                                                                             IER
LATEST REVISION
                                                                                                                                                        ٩
                                                                                                                                                        ARGUMENTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    COPYRIGHT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NOTATION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WAKRANTY
                                                 PURPOSE
                                                                                                   USAGE
```

SUBROUTINE MOBETI (P.A.B.X.IER) DATA

DATA

EPS/.0061/,SIG/1.E-4/,ITMAX/30/,ZERO/0.0/ SMEXE/-88.0/

FIRST EXECUTABLE STATEMENT

IER = 0

XL = AMIN1(A,B)

IF (XL.LE.O.O) GG TO 70

IF (XL.LE.1.0) GO TO 20

XR = AMAX1(A,B,

IF (30.0\*XL.LE.XR) GO TO 20
IC = 0

XL = 0.0 XR = 1.0

FXL = -P FXR = 1.0-P Ir (FXL+FXH.ul.ZERU) GU I∪ 65

```
DTEMP = ALGAMA (AA+BB) - ALGAMA (AA) - ALGAMA (BB)

DTEMP = DTEMP-(AA+BB)*ALOG (AA+BB)+(AA-.5)*ALOG (AA)+(BB-.5)

1*ALOG (BB)

DTEMP = DTEMP+.5*ALOG (BB/AA)+AA*ALOG(1.0+BB/AA)+BB*ALOG(1.+AA/BB)

DO 45 NC=1,200

TEMP = ALOG (15.0+AA+BB)

FEMP = ALOG (15.0+AA+BB)

FEMP = AA+FN+FN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ERROR RETURNED FROM MOBETA
USE NEWTONS METHOD FOR SKEWED CASES
IF (P.GT..5) GO TO 25
AA = A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  C = 1.G-(AA+BB)*XI/TEMP
ZI = 2.G/(C+SQRT(C+C-4.O*FN*(FN-BB)*XI/(TEMP*TEMP)))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      AFN = AFN-1.0

IF (AFN.LT..5) GO TO 40

IEMP = AA+AFN+AFN

ZI = (TEMP-2.0)**(TEMP-1.0-AFN*(AFN-BB)**XT*ZI/TEMP)

ZI = AA+AFN-1.0

ZI = 1.0/(1.0-TEMP*(TEMP+BB)**XT/ZI)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               15 XRMXL = XR-XL
IF (XRMXL.LE.SIG.AND.ABS(FCS),LE.EPS) GO TO 9005
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TEMP = ALUG(XT)

IF (TEMP.LE.SMEXE) GO TO 50

QX = DIEMP+AA*TEMP+BB*ALOG(1.-XT)+ALOG(2Z)

XC = (QO-QX)*(1.-XT)*2Z/AA

XC = AMAX1(XC,-.99)

TEMP = .5/XT-.5

XC = AMAX1(XC,-.99)
BISECTION METHOD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      55
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If (ABS(XC),LT,SIG) G0 T0
                                                                           CALL MDBETA (X,A,B,P1,1ER)

IF (IER.NE.0) GO TO 20

FCS = P1-P

IF (FCS*FXL.GT,ZERO) GO TO

KR = X
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            AFN = AINT(FN)+1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IER = 131
GD TG 9000
50 AT = 0.0
55 IF (P.GT..5) GO TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ALOG(1,0.P)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     3U XI = AA/(AA+BB)
                                          = (XL+XR)*5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ALOG(P)
                                                                                                                                                                                                                                                                                                               FXR . FCS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 = ALUL
                                                                                                                                                                                                                                                                                                                                                             GO TO 15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            45 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                   10 XL = X
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     AA BBB = 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000 : 000
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ALGAMA IS SET TO MACHINE INFINITY WHENEVER
X IS ZERO,
X IS A NEGATIVE INTEGER, OR
ABS(X), GE, XMAX.
XMAX IS OF THE ORDER OF 10\*\*36. THE EXACT
VALUE GF XMAX MAY ALLOW LARGER RANGES FOR
X ON SOME COMPUTERS. SEE THE PROGRAMMING
NOTES IN THE MANUAL FOR THE FÂACT VALUES.
MA - OUTPUT VALUE OF THE LOG (BASE F.) OF THE
ABSOLUTE VALUE OF THE GAMMA FUNCTION. AN ERROR MESSAGE PRINTED BY UERTST FROM ALGAMA SHOULD BE INTERPRETED AS FOLLOWS

IER - ERROR INDICATOR SINGLE/ALL
NOTE - ALGAMA MAY NOT BE SUPPLIED BY IMSL IF
IT RESIDES IN THE MATHEMATICAL SUBPROGRAM
LIBRARY SUPPLIED BY THE MANUFACTURER. INTRODUCTION OR THROUGH IMSL ROUTINE UHELP EVALUATE THE LOG (BASE E) OF THE ABSOLUTE VALUE OF THE GAMMA FUNCTION INFORMATION ON SPECIAL NOTATION AND CONVENTIONS IS AVAILABLE IN THE MANUAL RESULT = ALGAMA(X) - INPUT ARGUMENT REQD. IMSL ROUTINES - UERTST, UGETIO - MLGAMA=ALGAMA - JUNE 1, 1982 HIS/SINGLE CALL UERTST (IER, GHMDBETI) ALGAMA PRECISION/HARDWARE IMSL ROUTINE NAME LATEST REVISION × X = 1.0-XT GO TO 9005 0006 01 09 GO TO 90US 65 IER = 129 70 IER = 130 9000 CONTINUE ARGUMENTS 9005 RETURN COMPUTER NOIATION TX = X REMARKS PURPOSE USAGE 9

233333

TERMINAL ERROR

IER = 129 INDICATES THAT THE ABSOLUTE VALUE

OF THE INPUT ARGUMENT X WAS SPECIFIED

GREATER THAN OR EQUAL TO XMAX. ALGAMA
IS SET TO MACHINE INFINITY.

IER = 130 INDICATES THAT THE INPUT ARGUMENT

X WAS SPECIFIED AS ZERO OR A NEGATIVE

INTEGER. ALGAMA IS SET TO MACHINE

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IMSL WARRANTS UNLY THAT IMSL TESTING HAS BEEN APPLIED TO THIS CODE. NO OTHER WAKRANTY, EXPRESSED OR IMPLIED, IS APPLICABLE.
                                                                                                                                                                 SPECIFICATIONS FOR LOCAL VARIABLES IER. J. IEND. IEND. 1 END. 1 END.
                                                                                                                                                                                                                                                                                                                                                                                          V. T. R. XSIGN, A. B. TOP, DEN. EPS, BIG1, XINF, PI
P1(5), Q1(4), P2(5), Q2(4), P3(5), Q3(4), P4(3)
COEFFICIENTS FOR MINIMAX
APPROXIMATION TO LN(GAMMA(X)),
0.5. LE. X. LE. 1.5
P1(1)/-2: 9698959/, P1(2)/-24,4387534/,
P1(3)/-2. EUGBSS117, P1(4)/3.13060548/,
                                                                                                                                                                                                                                                                                                P1(3)/-2.tbbbbb...
P1(5)/11.16w7541/
Q1(1)/31.469011b/,Q1(2)/11.9400906/,
Q1(3)/.607771388/,Q1(4)/15.2346874/
COEFFICIENTS FOR MINIMAX
APPROXIMATION TO LN(GAMMA(X)),
APPROXIMATION TO ARCOGN.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             APPROXIMATION TO LN(GAMMA(X)),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     12.0 .LE. X
P4(1)/.918938533/,P4(2)/.833333215E-01/.
P4(3)/- 277092722E-02/
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                                                                                                                                    SPECIFICATIONS FOR ARGUMENTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 FIRST EXECUTABLE STATEMENT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IEND/5/, IEND1/4/, IEND2/3/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      P1/0004622077325/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 EPS/7.4506E-09/
BIG:/2.0590E36/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   XINF/1.69E38/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            S
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (ABS(T).LT.BIG!) GO TO
                                                                                                                    REAL FUNCTION ALGAMA(X)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      1F (T.GT.0.0) GO TO 20
1F (T.LT.0.0) GO TO 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              MFLAG = .FALSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ALCAMA = XINF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       GO TO 9000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         1ER = 129
                                                                                                                                                                              INTEGER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              1ER = 0
COPYRIGHT
                                                                                                                                                                                            LOGICAL
                            WARRANTY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ×
                                                                                                                                                  REAL
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 0 A T A D A I A D A I A D A T A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         4 143
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ARGUMENT IS NOT A NEGATIVE INTEGER
                                                                                                                                                                                                                                                                      EVALUATE APPROXIMATION FOR LN(GAMMA(T)), T .GT. 0.0
                                           ARGUMENT IS NEGATIVE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       1.5 .LE. T .LE. 4.0
                                                                                                                                                                                                                                                                                                                                                               0.0 .LT. T .LT. 0.5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       0.5 .LE. T .LT. 1.5
                                                                                                                      0.0) XSIGN = -1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              40 TOP = P1(IEND1)+T+P1(IEND)
D6N = T+Q1(IEND1)
D0 45 J=1,IEND2
TOP = TOP+T+P1(J)
DEN = DEN+T+P1(J)
45 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  0 B = T-1.0

A = B-1.0

TOP = P2(IEND1)*T+P2(IEND)

0 EN = T+Q2(IEND1)

D O SS J=1, IEND2

1 TOP = TOP*T+P2(J)

DEN = DEN*T+Q2(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      60 TOP : P3(IEND1)+T+P3(IEND)
                                                                                                 XS1GN = 1.0

IF (AMOU(R,2.0) EQ. 0.0

R = T-R

IF (R.NE.0.0) GG TO 15

IER = 130

ALGAMA = XINF

GO TO 9000
                                                                                                                                                                                                                                                                                                  IF (T.GT.12.0) GO TO 7U
IF (T.GT.4.0) GO TO 60
IF (T.GE.1.5) GO TO 50
IF (T.GE.0.5) GO TO 35
                                                                                                                                                                                                                                                                                                                                                                                                            T = T+1.0

IF (A.GE.EPS) GO TO 40

ALGAMA = B

GO TO 9005
                                                                                                                                                                                                                          R = PI/SIN(R*PI) *XSIGN
T = T+1.0
R = ALOG(ABS(R))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Y = (TOP/DEN)*A+B
IF (MFLAG) Y = R-Y
ALGAMA = Y
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Y = (TOP/DEN)+A
IF (MFLAG) Y = R-Y
162 - 130
ALGAMA - XINE
GO TO 9000
                                                           MFLAG - . TRUE.
                                                                                                                                                                                                                                                                                                                                                                                = -ALOG(T)
                                                                         T = -T
R = AINT(T)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GO TO 9005
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               55 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        T0P
                                                                                                                                                                                                                                                                                                       20 IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        20
                                                                                                                                                                                                                             ē
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        35
                                                            2
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- PRINT A MESSAGE REFLECTING AN ERROR CONDITION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             1 = 64 IMPLIES WARNING WITH FIX MESSAUE,
1 = 32 IMPLIES WARNING MESSAGE.
J = ERRÜK CODE RELEVANT TO CALLING
ROUTINE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            A CHARACTER STRING OF LENGTH SIX PROVIDING THE NAME OF THE CALLING ROUTINE. (INPUT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      R = 1+J WHERE
I = 128 IMPLIES TERMINAL ERROR MESSAGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONVENTIONS IS AVAILABLE IN THE MANUAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            THE ERROR MESSAGE PRODUCED BY UERTST IS MRITTEN TO THE STANDARD OUTPUT UNIT. THE OUTPUT UNIT NUMBER CAN BE DETERMINED BY CALLING UGETIO AS FOLLOWS... LALL UGETIO(1.NIN.NOUT).

THE OUTPUT UNIT NUMBER CAN BE CHANGED BY CALLING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              INFORMATION ON SPECIAL NOTATION AND
                                                                                                                                                                                          12.0 .41. X .LT. BIGI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              - ERROR PARAMETER, (INPUT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       - CALL UERTST (IER, NAME)
                                                                                                                                                                                                                                                                                                               TOP = (P4(3)*B*P4(2))*T*P4(1)*T0P
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  MEQD. IMSE ROUTINES - UGETIO, USPKD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    JUNE 1, 1982
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               - HIS/SINGLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               - SINGLE/ALL
                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL DERIST("ILR, OMMLGAMA)
CALL DERIST(TER, OMALGAMA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             - UERISI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        EE
                                                                                                                                                                                                            73 TOP = ALOG(T)

10P = T \cdot (10P - 1.0) - .5 \cdot 10P
                                                                                                                                                                                                                                                 T = 1.0/T

1F (T.LT.EPS) GO TO 75

B = T+T
DEN = T+Q3(TEND1)
DU 05 J+1, TEND2
TOP = TOP+1+P3(J)
DEN = DEN+1+Q3(J)
                                                                                                                                                                                                                                                                                                                                                          IF (MFLAG) Y = R-Y
ALGAMA = Y
                                                                                                                          IF (MFLAG) V = H-V
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             JAEC ISTON/HARDWAKE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IMSE ROUTINE NAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                HAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    LAIEST KEVISION
                                                                                                         Y = 10P/DEN
                                                                                                                                                                     GO TO 9005
                                                                                                                                                                                                                                                                                                                                                                                                     GO 10 9005
                                                                                                                                                 ALCAMA = Y
                                                                                   CS CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                    SUDD CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              PRCUMENTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             COMPUTER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              MOTATION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PURPOSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                REMARKS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       USAGE
                                                                                                                                                                                                                                                                                                                                      75
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    3005
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IMSL WARRANTS ONLY THAT IMSL TESTING HAS BEEN APPLIED TO THIS CODE. NO OTHER WARRANTY, EXPRESSED OR IMPLIED, IS APPLICABLE.
                                                                                                                                                                                                                                                                                                                   SPECIFICATIONS FOR LOCAL VARIABLES
                                                                                                                                                                                                                                                                                                                                   I, IEU, IEGDF, IOUNIT, LEVEL, LEVOLD, NAMEQ(6),
NAMSET(6), NAMUPK(6), NIN, NMTB
NAMSET/1HU, 1HE, 1HR, 1HS, 1HE, 1HT/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           PRINT WARNING WITH FIX MESSAGE (IEQDF.EQ.1) WRITE(ICUNIT.40) IER,NAMEQ,IEQ,NAMUPK (IEQDF.EQ.0) WRITE(IOUNIT.40) IER,NAMUPK
                                                                            - 1982 BY IMSL, INC. ALL RIGHTS RESERVED
                                                                                                                                                                                                                                                         SPECIFICATIONS FOR ARGUMENTS
NOUT = NEW OUTPUT UNIT NUMBER
                                                                                                                                                                                                                                                                                                                                                                                                                  LEVEL/4/, IEQDF/0/, IEQ/1H=/
UNPACK NAME INTO NAMUPK
FIRST EXECUTABLE STATEMENT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        PRINT TERMINAL MESSAGE (IEQDF.EQ.1) WRITE(IOUNIT.35) IER,NAMEQ,IEQ,NAMUPK (IEQDF.EQ.0) WRITE(IOUNIT.35) IER,NAMUPK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                (LEVEL.LT.3) GO TO 30
(IEQDF.EQ.1) WRITE(IOUNIT,4S) IER.NAMEQ,IEQ,NAMUPK
(IEQDF.EQ.0) WRITE(IOUNIT,4S) IER.NAMUPK
                CALL UGETIO(3.NIN,NOUT)
SEE THE UGETIO DOCUMENT FOR MORE DETAILS.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GET OUTPUT UNIT NUMBER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PRINT WARNING MESSAGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CHECK FOR UERSET CALL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 20 I=1.6
IF (NAMUPK(I).NE.NAMSET(I)) GO TO 25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CHECK LER
                                                                                                                                                                                                                                                                                                                                                                                                 NAMEO/6+1H /
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL USPKD (NAME, 6, NAMUPK, NMTB
                                                                                                                                                                                                                                   SUBROUTINE UERTST (IER, NAME)
                                                                                                                                                                                                                                                                                              NAME (1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL UGETTU(1, NIN, IOUNIT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TO 30
(1ER.LE.64) GO TO 10
(LEVEL.LT.2) GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (IER.GT.999) 60 TO 25
IF (IER.LT.-32) 60 TO 55
IF (IER.LE.128) 60 TO 5
IF (LEVEL.LT.1) GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           (IER.LE.32) GO TO 15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 (LEVEL.GT.0) LEVEL
(LEVEL.GT.4) LEVEL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LEVOLD = LEVEL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      LEVEL = 1ER

IER = LEVOLD

IF (LEVEL,LT,C)

IF (LEVEL,GT,A)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 20 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                          INTEGER
                                                                                                                                                                                                                                                                                                                                     INTEGER
                                                                            CUPYRIGHT
                                                                                                                 WARRANTY
                                                                                                                                                                                                                                                                                                                                                                            DATA
                                                                                                                                                                                                                                                                                                                                                                                                                    DATA
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              F F G F F
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    5
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UČETIO AS FULLOMS.

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- OPTIUN PARAMETER. (INPUT)

IF 10PT=1, THE CURRENT INPUT AND OUTPUT
UNIT IDENTIFIER VALUES ARE RETURNED IN NIN
AND NOUT, RESPECTIVELY

IF 10PT=2, THE INTERNAL VALUE OF NIN 1S
RESET FOR SUBSEQUENT USE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   INFORMATION ON SPECIAL NOTATION AND CONVENTIONS IS AVAILABLE IN THE MANUAL INTRODUCTION OR THROUGH IMSL ROUTINE UMELP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF IOPT=3, THE INTERNAL VALUE OF NOUT IS RESET FOR SUBSEQUENT USE.

INPUT UNIT IDENTIFIER.

OUTPUT IF IOPT=1, INPUT IF IOPT=2.

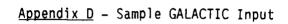
OUTPUT UNIT IDENTIFIER.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TO RETRIEVE CURRENT VALUES AND TO SET NEW VALUES FOR INPUT AND OUTPUT UNIT
                                                    PRINT NON-DEFINED MESSAGE IF (IEQDF.EQ.1) WRITE(IOUNIT,50) IER,NAMEQ,IEQ.NAMUPK IF (IEQDF.EQ.0) WRITE(IOUNIT,50) IER,NAMUFK
                                                                                                                                                                                                                                                                                                                                                                                     SAVE P FUR P = R CASE
P IS THE PAGE NAMUPK
R IS THE ROUTINE NAMUPK
                                                                                                                                                                        35 FORMAT(19H *** TERMINAL ERRUR, 10X, 7H(IER = .13, 20H) FROM IMSL ROUTINE ,6A1,A1,6A1)
40 FORMAT(27H *** WARNING WITH FIX ERROR, 2X, 7H(IER = .20H) FROM IMSL ROUTINE ,6A1,A1,6A1)
45 FORMAT(18H *** WARNING ERRUR, 11X, 7H(IER = .13, 20H) FROM IMSL ROUTINE ,6A1,A1,6A1)
50 FORMAT(20H *** UNDEFINED ERRUR,9X, 7H(IER = .15, 12, 20H) FROM IMSL ROUTINE ,6A1,A1,6A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL UGETIO(IOPT, NIN, NOUT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IDENTIFIERS.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NONE REQUIRED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            JUNE 1, 1981
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               - SINGLE/ALL
                                            IF (LEVEL,LT,4) ou lo 30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 60 1=1.0
60 NAMEQ(I) = NAMUPR(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       REGD. IMSL ROUTINES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PRECISION/HARDWARE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IMSL ROUTINE NAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IOPT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      LATEST REVISION
                                                                                                                                                                                                                                                                                                                                                                                                                                                       55 IEQDF = 1
GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ARGUMENTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             COMPUTER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PURPUSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               USAGE
                       25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      65
                                                                                                                                                                                                                                                                                                                                                              \cup \cup \cup \cup
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USPKD UNPACKS A CHARACTER STRING INTO AN INTEGER ARRAY
                                                                                                                                                                                IMSL WARRANTS ONLY THAT IMSL TESTING MAS BEEN APPLIED TO THIS CODE. NO OTHER WARRANTY, EXPRESSED OR IMPLIED, IS APPLICABLE.
EACH IMSL ROUTINE THAT PERFORMS INPUT AND/OR OUTPUT OPERATIONS CALLS UGETIO TO OBTAIN THE CURRENT UNIT DENTIFIER VALUES. IF UGETIO IS CALLED WITH IOPT=2 OR IOPT=3. NEW UNIT IDENTIFIER VALUES ARE ESTABLISHED. SUBSEQUENT INPUT/OUTPUT IS PERFORMED ON THE NEW UNITS.
                                                                                                                                                                                                                                                                                                                                                                                       SPECIFICATIONS FOR LOCAL VARIABLES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   S.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NUCLEUS CALLED BY IMSL ROUTINES THAT HAVE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL USPKD (PACKED, NCHARS, UNPAKD, NCHMTB)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ANY IN EXCESS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PACKED - CHARACTER STRING TO BE UNPACKED. (INPUT)
NCHARS - LENGTH OF PACKED. (INPUT) SEE REMARKS.
UNPAKD - INTEGER ARRAY TO RECEIVE THE UNPACKED
REPRESENTATION OF THE STRING. (OUTPUT)
NCHMTB - NCHARS MINUS TRAILING BLANKS. (OUTPUT)
                                                                                                                                     - 1978 BY IMSL, INC. ALL RIGHTS RESERVED.
                                                                                                                                                                                                                                                                                                                 SPECIFICATIONS FOR ARGUMENTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                           FIRST EXECUTABLE STATEMENT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CHARACTER STRING ARGUMENTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 UP TO 129 CHARACTERS MAY BE USED.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NUVEMBER 1, 1984
                                                                                                                                                                                                                                                                                                                                                                                                                                    NIND/5/, NOUTD/6/
                                                                                                                                                                                                                                                                                                                     SUBROUTINE UGETIO( TOPT, NIN, NOUT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                HIS/SINGLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               - SINGLE/ALL
                                                                                                                                                                                                                                                                                                                                                                                                             NIND, NOUTD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          THAL ARE IGNORED.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IN (A1) FURMAT.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (IOPT.EQ.3) GO TO 10
IF (IOPT.EQ.2) GO TO 5
IF (IOPT.NE.1) GO TO 9005
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ROUTINES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PRECISION/HARDWARE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IMSL ROUTINE NAME
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GO TO 9005
NIND = NIN
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10 NOUTD = NOUT
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                                                                                                                                       COPYRIGHT
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        9008
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SET NC=NUMBER OF CHARS TO BE DECODED
                                         - IMSL WARRANTS ONLY THAT IMSL TESTING HAS BEEN APPLIED TO THIS CODE. NO OTHER WARRANTY, EXPRESSED OR IMPLIED, IS APPLICABLE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CHECK UNPAKD ARRAY AND SET NCHMTB
BASED ON TRAILING BLANKS FOUND
   ALL RIGHTS RESERVED.
                                                                                                                                              SUBROUTINE USPKD (PACKED, NCHARS, UNPAKD, NCHMTB)
SPECIFICATIONS FOR ARGUMENTS
INTEGER
NC, NCHARS, NCHMTB
                                                                                                                                                                                                                                                                                                                                           RETURN IF NCHARS IS LE ZERO
                                                                                                                                                                                                                                                                                                 INITIALIZE NCHMTB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 200 N = 1,NC
NN = NC - N + 1
IF(UNPAKD(NN) .NE. IBLANK) GO TO 210
- 1984 BY IMSL, INC.
                                                                                                                                                                                                                                                                                                                                                                                                       NC = MIND (129,NCHARS)
READ(PACKED,150) (UNPAKD(I),I=1,NC)
FORMAT (129A1)
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PACKED
                                                                                                                                                                                                                                                                            IBLANK / 1H /
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CHARACTER*6
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NN = 0 210 NCHMTB = NN RETURN END

200 CONTINUE



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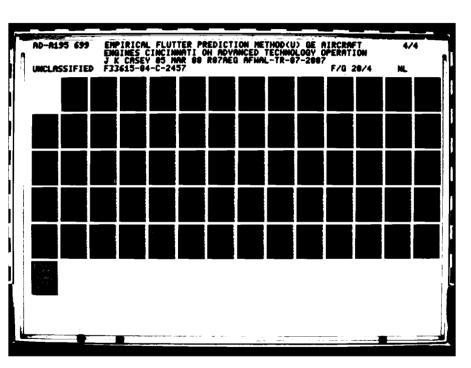
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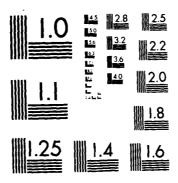
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MICROCOPY RESOLUTION TEST CHART NATIONAL BUREAU OF STANDARDS-1963-A

Appendix E - Sample GALACTIC Output

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the longest \*19E-W3 EERGK.CASEYJDPO16 EDG/1 (375,6/0), last revised on 11-APR-1987 22,52, is a 160 block sequential file owned by UIC his records are variable length with a fixed control size of 2 bytes and print file (PRN) carriage control corned is 29 bytes. 107-17

The blate (it queued to 12AG on 12-APR-1987 12:11 by user CASEY, UIC ECASEY), under account 6761 at pricrity 100, started on 12-APB-1987 LS 10 from queue TXAO. ALECTION FLANCE 11 1 1 1 1 1 2 1

CHARACARACA **カア なれんたみなん**か HILDER STATEMENT OF THE PROPERTY OF THE PROPER 46.77 2012/03/2014 30/11/2012/2014

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This version is from the DEO VAX cluster in building 200 at column J5. This file will need to be customized for other systems in most cases. Any questions may be directed to Ric West at ext. 6-2630. Set up the logicals and symbols for Patran?
                                                                                                                                                                                                                                          OM CONTROL_Y THEN GOTO START ! cannot control Y out of this procedure
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CUYCLOGIN. COM system-wide standard user login command file.

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OF THERE OF OUR MOTHRITE, OR WRITE FOLLOWING OUTPUT OPTIONS.
FOR ALLEGATAS SMALNIR, MPT, BAX, BTR, BPT

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MINITHUM OF HIPERPLANE RHS FOR LEFT SELS
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-0.0631 -0.6260
-0.0631 -0.6260
MAXIMUM OF HYPERPLANE RHS FUR RIGHT SERS
-0.1208 -0.0633 5.5561 0.1161 0.0376 -0.0396 -0.4825 -0.0264

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	MPRINEMENTS TO HYPERPLANE LEFT HAND STIDES	HIGHTOLD	0. 6278E-01 0. 3750E-01 0 6278E-01 0. 3758E-01	-0. 3930E-01-0. 3944E-01-0. 3931E-01-0. 39 <b>64</b> E-01	0. 5907E-01-0. 2640E-01 0. 5907E-01-0. 2640E-01	-0. 6306E-01-0. 8351E-01-0. 6306E-01-0. 8351E-01	-0. 6250E+00-0. B486E+00-0. 6260E+00-0. B4B6E+00
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HAME REVISED SAMPLE & POPULATION FILES (IN SAMPLE FORMAT)(\* \* IF NONE)

COMPLET
ENTER WILE 14)THEN ID OF N SETS TO BE EXCLUDED (-1 FOR ALL NEW SETS)

ENTER WILE 20) THEN MAME N POPULATION POINTS TO BE EXCLUDED

6
6MTER MITHEN N PAIRS OF IDS TO BE LABELED AS THE FIRST

9, 9999> 0, 1854>-0, 4277<-0, 0581< 0, 3334>-0, 2406< 9. 9999> 0. 0964#+0. 3426<+0. 1419< 0. 2650>+0. 2365< 6. 45170 0. 01724-0. 06970 0. 06270 0. 38540 0. 0111= 0, 14942-0, 04890 G. 14037-0, 03870 0227> 0.8526>-0.1498< 0.2218>-0.1121< 0.1697>-0.1046< 9,9999> 0,1667>-0,4119<-0,0670</br> 9.9999> 0.1660>-0.3894<-0.0533< 0.3104>-0.2114< 9, 9999> 0, 2066>-0, 4869<-0, 0226> 0, 3050>-0, 2305< 9.9999> 0.2016>-0.4722< 0.0566> 0.0787>-0.1235< 0976< 9, 9999> 0, 1740>-0, 4324<-0, 0377> 0, 2087>-0, 2150< 0, 16535-0, 3971<-0, 0689< 0, 2269>-0, 2362< 0.1934>-0.2833< 0.0744>-0.0552>-0.0253= 9.9999> 0.1912>-0.2623< 0.0498>-0.0414>-0.0441< 0573< 9, 1913> 0, 1731>-0, 2379< 0, 0089>-0, 0087>-0, 0771< 0635< 9,9999> 0,1863>-0,3180< 0,0821>-0,1217>-0,0337< 0156<-6, 9810</td>
 0, 1722<-0, 1368</td>
 0, 0539>-0, 1731>
 0, 0443=
 0. 0938#+0 2904<+0 1922< 0. 3360>+0, 2631< (315< 9, 9999> 0, 1018#-0 4035<-0, 0626< 0, 1991>-0, 1776< 0.0175>-0.1620< 4. 8263> 0. 0790#-0. 2759<-0. 1635</br> 00933 1, 92403-0, 0311# 0, 10203-0, 2154< 0, 60303-0, 2136< 3.0883>-0.0223# 0.0756>-0.1767< 0.5645>-0.1863< 3.83012-0.0152# 0.0064<-0.0561< 0.49242-0.0813< 5. 1973/-0, 0001#-0, 0211<-0, 0199> 0, 4498>-0, 0569< 0. 6683#-0. 6487< 0. 0269> 0. 4173>-0. 0181= 0.0268#~0.0801<0.0740> 0.3667> 0.0165= 2, 80875 0, 0523H-0 0546< 0, 00345 0, 14005-0, 0365< 4, 2460> 0, 0650#~0, 0694< 0, 0175> 0, 11861~0, 0322< 0. 1007#+0. 3456<-0. 1401<-0. 3050>-0. 0. 0726#-0. 3310K-0. 0946K 2. 84083- 0. 0519#~0. 0527 0.05304-0.05130-0.0085> 8. 51692 5, 82352 9.9999> 9. 9999> 9.51157 <6666 6 7, 32293 2, 90342 **>0260** >9680 0466< 2436< 6 0, 10505-0, 16284 0940C 1180 2600 **36+01** 01115 VBB10 **1368** 4888> 3820> 1759> 0510 1199 6 0.2499>-0. -0.1825<-0. 03000 1454<-0. 340<-0. 3815-0 21974-0. 0-<50.00 0561>-0. 4400-0 1299 6 0. 6 3 VOC 1150 0.0 10% 1399 1499 1599 1010 6532 5343 5466 (350 1. 978 666 6602 2199 04:2 6482 Child (15) 1.4. (.6) 1/95 1000

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9, 9999> 0, 1258#-0 1696< 0, 2059>-0, 0603> 0, 1121>
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## EBRES MAME OF NEXT PUPULATION FILE (\* \* 18 NONE)

SI POINTS ON REVISED SAMPLE FILE

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9. 9999> 0. 1727>-0. 4772<-0. 1720< 0. 4987>-0. 3396<

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RHS IS - 0.179E-01*V(1) - 0.103E-02*V(2) - 0.564E+00*V(3) - 0.124E-03*V(4) - 0.266E-03*V(5) - 0.206E-01*V(6) - 0.827E-04*V(7) - 0.324E-01*V(8) - 0.396E-02*V(9)
                                                                                                                                                                                                                                                                            RHS IS + 0.490E-03*V( 1) + 0.194E-03*V( 2) - 0.116E-01*V( 3) - 0.341E-02*V( 4) + 0.104E-02*V( 5) + 0.645E+00*V( 6) - 0.541E-03*V( 7) - 0.413E-02*V( 8) + 0.247E-01*V( 9)
                                                                                                                                                                                                                                                                                                                                                                                                                                + 0.626E+00*V( 4) + 0.123E+00*V( 1) - 0.185E-01*V( 2) - 0.829E+01*V( 3) - 0.626E+00*V( 4) + 0.123E+00*V( 5) - 0.865E+00*V( 6) - 0.151E-02*V( 7) HYPERH AND FOLLOWS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         HHS IS - 0.150E-02*V(1) + 0.358E-03*V(2) + 0.203E+00*V(3) + 0.321E-02*V(4) + 0.103E-02*V(5) + 0.52E+00*V(6) - 0.445E-03*V(7) - 0.432E-01*V(8) + 0.847E-02*V(9)
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                                                                                    RIES IS -0.187E-02*V(1) + 0.481E-03*V(2) - 0.917E-01*V(3) + 0.583E-02*V(4) - 0.165E-01*V(5) + 0.458E+00*V(6) - 0.275E-03*V(7) <math>-0.725E-01*V(8) - 0.211E-01*V(9)
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                                            HYPERPLANES FOR SETS 11-0. 2332E+00 LE RHS)& 21-0. 2061E+00 GE RHS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             HYPERPLANES FOR SETS 1( 0.2736E+00 LE RHS)& 5( 0.5548E+00 GE RHS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     HYPERPLANES FUR SETS 2(-0, 2196E+00 LE RHS) $ 3(-0, 244BE+00 GE RHS)
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Job CHIG (2) queued to TXAO on 12-APR-1987 12.11 by user CASEY, UIC ECASEY1, under account 6761 at priority 100, started on printer AEL2504TXAO on 12-AFR-1987 12.13 from queue TXAO.

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0.5280035

0. 4961410

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0E+00 5.7865065E-05 -1.0996808E-02 -1.9000837E-03 -2.263177 -2.450073 0.000000E+00 0.0000000E+00 2.2439579E-04 0. 0000000E+00 O. 00000000E+00 -1. 4671807E-03 -0.1627179 0. 0000000E+00 0. 0000000E+00 -0. 1090021 0. 0000000E+00-0. 0000000E+00 -8. 9843273E-02 1. 9169506E -1.3261826E Appendix F - Sample EFAGHY Input

VAX4> TYPE EFI1.DAT;34 1 '55777B' 20 'Y' 'FLPLANES' ',' 0 0 0 0 0 0 0 0 0 0

VAX4> LO

Appendix G - Sample EFAGHY Output

First is presented the output that resulted from the batch input of Appendix F.

Then the output from a time sharing session of a slightly later version of EFAGHY. Being in time sharing, the input is an integral part of the output.

```
VAX4>
VAX4>
VAX4> TYPE EF01.LOG;1
        SYSLOGIN.COM system-wide standard user losin command file.
$
        This version is from the DEO VAX cluster in building 200 at column
        This file will need to be customized for other systems in most
$
        cases. Any questions may be directed to Ric West at ext. 6-2630.
 ! Set up the losicals and symbols for Patran2
* @PATRAN&DIR:PATNAMES
$ VERIFY=1
$ SET NOVERIFY
$ EXIT
$START:
$ ON CONTROL+Y THEN GOTO START ! cannot control Y out of this procedure .
$ SET NOON
* NODE = F*GETSYI("NODENAME")
  SAVE+VERIFY = F$VERIFY(0)
        set up user enviroment
$ PROMPT = F$LOGICAL("NODE+NAM")+"> "
$ SET PROMPT = DE01>
$ SET CONTROL=(T,Y)
$EXIT:
$ @LOGIN
        LOGIN.COM
        User default losin command file for VAX DEO1. Inserted by
        NEWU.COM when a new user is added to the system.
        Add user features below this line:
$ EXIT
$ ASSIGN EFI1.DAT FOROOS
%DCL-I-SUPERSEDE, previous value of FOROO5 has been superseded
$ RUN EFACHY
  EFACHY (EMPIRICAL FLUTTER ANALYSIS BY GALACTIC HYPERPLANES)
RUN ON 05/22/87 AT 16.75 HOURS ON BATCH
 ENTER NUMBER & NAMES OF DATA FILES, WORDS/RECORD, Y/N TO CLEARFILES
          1 55777B
         20 Y
 NAME GALACTIC HYPERPLANE FILE
FLPLANES
 NAME OUTPUT FILE FOR SET ASSIGNMENTS ,' ' TO PRINT
 ENTER N (LE
                       14) THEN ID OF N SETS TO BE EXCLUDED
 ENTER N, THEN N PAIRS OF IDS TO BE LABELED AS THE FIRST
 ENTER N THEN THE N HYPERPLANES TO BE USED (O O FOR ALL)
 ENTER O OR 1 TO NOTWRITE OR WRITE THE FOLLOWING OUTPUT OPTIONS
 HYP, PTS, VOT, ASS, ASP
 PT# ACTID CANID YVOTE NVOTE OVOTE GVOTE CVOTE MAX%O MAX%G WVOTE BYOTE
 DATA FROM FILE 55777B
                    10*
       21
             21
                           2
                                                  0.7
                                                        0.0
                                        0
                                                              10.7*
                                                                     8.3*
                           4
                                              5
                                                              8.8
              0
                     7
                                 2
                                        0
                                                  1.0
                                                        0.0
                                                                     4.5
               1
                     4
                           6
                                 2
                                                  0.7
                                                        0.8
                                                               4.9
                                                                    -3.1
                                        1
                                              1
                     8
                                                  0.0
                                                        0.2
                                                               8.8
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		3	5 5	. 7	0	1	-1	0.0	0.1	5.9 -1.2
		4 5 6	6 1 1	4 11 8	1 0 0	2 1 4	5 -9 -3	0.1 0.0 0.0	0.7 0.6 0.7	7.3 1.7 1.4 -10.1 2.9 -7.2
		6 7 10 20	1 3 7 5 9	11 8 7 0 4 3 4 6	1 6 1	2 0 3	-3 -1 13* -5	0.3 0.9 0.8	0.6 0.0 0.9	2.9 -7.2 4.7 -3.6 9.3 5.7 7.3 1.6 9.6 6.2 4.6 -3.7 4.2 -3.5 11.3 9.7 12.1* 11.2* 11.9 10.4 10.4 7.9 3.2 -6.7 1.9 -9.1
		22 23 27	9 1 3	3 4 6	1 1	0 7 4	7 5 1	0.6 0.7 0.0	0.0 1.0 0.8	9.5 6.2 4.6 -3.7 4.0 -3.5
2	1 1	2 1 0	3 11* 10 9	0	0 2 3 4	0	13* 13* 13*	$0.3 \\ 1.0$	0.0	11.3 9.7 12.1* 11.2*
		3 4	10 3	2 9	1 0	0	9 -5	0.9	0.0	10.4 7.9 3.2 -6.7
		3 4 5 6 7	3 5	0 0 0 2 9 10 7 6 4	0 0 2	2 3 0	-7 -1 1	0.0	0.8 0.9 0.0	1.9 -9.1 4.2 -4.5 5.6 -1.8
		10 20 21	10 3 1 3 5 4 6 2 5 0	5 6	0 2 5 2 2 0	0 3	1 3 1 -3 -7	0.5 0.9 0.6	0.0 0.0 0.7	5.8 -1.3 7.6 2.2
		22 23 27	5 0 4	8 10 6	0 1 0	0 2 3	-3 -7 1	0.0 0.6 0.0	0.7 0.0 0.8 0.3	4.5 -4.0 5.0 -3.0 1.1 -10.7 6.4 -0.2 12.3* 11.6* 10.9 9.3 5.5 9.4 5.7 5.2 -2.6 2.3 -8.3 5.8 -1.4 9.5 6.0 4.8 -3.5 2.1 -6.7 6.1 -9.4 5.2 -2.6
3	0	0 1	10* 10*	0 2 2	3 1 2	0 0 1	13* 9	0.8 0.9 0.9	0.0	12.3* 11.6* 10.9 8.9
		2 3 4 5 6	8 9 4	7	3 1 2 2 1 0	0	9 -1	0.2 0.2	0.0	9.4 5.7 5.2 -2.6
		6 7 10	1 3 9 4	5	0	2 5 1	-7 3 7	0.0	0.9	2.3 -8.3 5.8 -1.4 9.5 6.0
		20 21	2 1 6	7 9	1 1	0 3 2 0	5 -1 -5 1	0.7 0.7 0.6	0.0 0.5 0.7	5.1 -0.0 4.8 -3.5 2.1 -8.7
		22 23 27 3	6 0 4 11*	6 9 5	1 1 0	0 3 4	1 -5 3	0.3 0.6 0.0	0.0 0.9 1.0	6.3 -0.4 1.8 -9.4 5.2 -2.6
4	2 2	3 2 0	11* 9 9	02227053479695120	0 5 1 1 1 1 0 1 2 4 2 0	0 0 0	11 9 13*	0.4 0.2 1.0	0.0	11.4 9.7 9.2 5.3
		1 4	10 4 1	i 8	2 0 0	0	11 -3 -7 -1 5	1.0 0.0 0.0	0.0	11.4 9.7 9.2 5.3 12.2* 11.3* 11.0 9.1 4.5 -4.0 2.1 -8.9 4.7 -3.6 8.1 3.2 5.5 -2.0
		5 6 7 10	3 7 4	1 8 10 7 4 3 7	0 1 6	3 1	-1 5	0.0	0.5 0.7 0.9	4.7 -3.6 8.1 3.2
		20 21	3 1	_	2	0 1 2	7 -1 -3	0.4 1.0 0.4 0.9	0.0 0.0 0.6	5.5 -2.0 5.6 -1.7 2.6 -7.9 6.9 0.8
_		22 23 27	6 0 4	10 5	1 0	2 0 2 4	-3 1 -7 3 13*	0.6	0.0 0.8 1.0	6.9 0.8 1.1 -10.7 6.1 -0.9
5	0	0 1 2	10* 9 7	0 2 3	3 1 2	0 1 1	13* 9 7	1.0 0.9 0.3 0.7	0.0 6.0	12.5* 11.9* 10.4 7.7 8.4 3.7
		1 2 3 4 5 6	ڊ 6 1	2 6 10	2 1 0	0 0 2	9 1 -7	0.7 0.0 0.0	0.0	9.9 6.8 5.0 -0.9
		6 7 10	4 10* 9 7 9 6 1 4 9 5 2 1 4	8610502326043489885	2 1 0 2 1 2 2 1 0 0 0 4	0 0 2 5 1 0 2 2	9791757535333	0.0	0.7 0.3	2.6 -7.9 6.9 0.8 1.1 -10.7 6.1 -0.9 12.5* 11.9* 10.4 7.7 8.4 3.7 9.9 6.8 6.9 0.8 9.7 6.4 6.5 -0.0 4.1 -4.8 1.8 -9.3 4.7 -8.6 5.5 -2.0
		20 21 22	2	8 9	1 1 0	2	-3 -5,	0.7 0.6	0.0 0.3 0.9	4.1 -4.8 1.8 -9.3
		23 27	1 4	8 <b>5</b>	0 1 0	1 3 4	-3 -3 -3	0.0 0.6 0.0	0.3 1.0 0.8	4.7 -3.6 2.2 -8.6 5.5 -2.0

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-	6	21	21 0 1	10* 9 6	2 0 5	1 4 1	0 0 1	ი 13* 3	0.8 1.0 0.4	0.0 0.0 0.4	10.8 8.5 11.2* 9.5* 7.1 1.1
			2 3 4	6 9 3	5 2 9	2 1 ·1	0 1 0	3 9 ~5	0.9 0.3 0.8	0.0 0.7 0.0	7.4 1.9 10.1 7.2 3.8 -5.5
			5 6 7	1	11 9 7	0 3	1 1 0	-9 -5	0.0	0.3	1.7 -9.6 3.7 -5.6
. is	•		10 20	35285	5 3	1 6 1	0	-1 3 7	0.1	0.0	2.1 -6.9 9.4 5.7
ঞ	_		22 23 27	0 9	6 10 2	i i 0	1 2 2	-7 -9	0.6 0.9 0.0	0.3 0.7 0.6	6.3 -0.4 1.4 -10.1 10.0 7.0 11.1 9.2
	7	1	1 0 2	11* 9	0 0 2	2 4 1	0 0 1	13* 13* -	0.1 0.9 0.1	0.0 0.0 0.8	12.3* 11.6* 9.3 5.6
. •			0 2 3 <b>4</b> 5	9 3 1	3 10 10	1 0 0	0 0 2	7 -7 -7	0.4 0.0 0.0	0.0 0.0 1.0	9.4 5.7 3.0 -7.0 1.8 -9.5
· 🕜			6 7 10	3 6 4	9 6 <b>4</b>	0 1 5	1 0 0	-5 1 5	0.0 1.0 0.4	0.2 0.0 0.0	3.8 -5.6 7.0 1.0 5.6 -1.9
G			20 21 22	8 3 4	<b>4</b> 8 8	1 1 1	0 1 0	5 -3 -3	0.8 0.6 0.6	0.0 0.0	8.8 4.5 4.6 ~2.8 4.6 ~3.9 1.1 ~10.8
	8	21	23 27 21	0 8 10*	10 4 1	1 0 2	2 1 0	-7 5 11	0.7 0.0 0.7	0.8 0.2 0.0	1.1 -10.8 8.8 4.5 11.1* 9.2*
: . (;			0 1 2	8	1 6	4 1 1	0 0 1	11 1 7	0.9 0.3 0.2	0.0 0.0 0.1	10.8 7.7 6.3 -0.5 9.0 5.1
(°)			1 2 3 4 5 6	8 7 3 1	3 4 7 11	1 2 0	1 1	5 -1 -9	1.0 0.5 0.0	0.8	9.0 5.1 8.7 4.5 3.9 -5.3 1.6 -9.8
. "; <i>:</i> "			6 7 10	2 3 4	8 0	0 2 9	3 0 0	-3 -3 13*	0.0 0.5 0.8	0.9	3.5 -6.0 3.9 -5.2
			20 22 23	8 6 0	2 5 10	1 2	2 0 2	9 3	0.9 0.9	0.8	9.6 6.2
•	9	0	27 0	4 11* 10	4 0	0 2 0	5 0 1	-/ 5 13*	0.8 0.0 0.9	0.7 0.9 0.0	- 12、84 - 12、64
			1 2 3 4	<b>4</b> 8	2 7 2 4	0 1	2 2	9 -1 9	0.0	0.7 0.5 0.3	10.3 7.7 5.2 -2.7 9.5 6.0 7.8 2.6
			5	7 3 5	9	1 0 0	1 1 4	5 -5 5	0.1	0.4 0.6	3.6 -5.9
•			10 20	5 10 5 2 1 4	4 3 3 9 10	0 5 1	0 0 1	7 7 -5 -7 -5	0.0 0.9 0.7	0.0 0.0 0.7	10.0 7.0 7.1 1.2 3.0 -7.1
			21 22 23	1	9 7	1 0 1	1 0 4 3 0	- 1	0.6 0.0 0.6	0.4 0.0 1.9	2.2 -9.6 4.0 -5.0 2.4 -9.2
<b>V</b>	10	0	6 7 10 20 21 22 23 27 3 0 1 2 4 5 6 7	4 10* 8 6 8 4 6 4 9	6 2 0 5 2 7	0 1 5 2 3 1	o	1 9 13* 3 9	0.0 0.4 0.9	0.8 0.0 0.0	7.6 2.1 10.0 7.0 7.1 1.2 3.0 -7.1 2.2 -9.6 4.0 -5.0 2.4 -8.2 5.0 -1.8 10.4 7.8 11.4* 9.9* 6.8 0.6 9.7 6.4 4.7 -3.6 6.8 0.5 5.7 -1.6 9.2 1.5 5.4 -0.2
			1 2 4	6 8 4	5 2 7	2 3 1	0 0 1	3 9 -1	0.6 0.9 0.1	0.0 0.0 0.4	6.8 0.6 9.7 6.4 4.7 -3.6
			5 6 7	6	6 6 3 3	0 0 1 6	1 3 0	1 1 7	0.0 0.0 0.2	0.2	6.8 0.5 5.7 -1.6 9.2 5.4
•			10 20	4 5	3	6 1	ŏ 1	7	0.8 9.5	0.0	7.2 1.5 5.4 -0.2

11	0	21 22 23 27 0 3 1 2 4 5 6	36109** 968273848351	85 10 11 02 52 10 56 33 37	1 2 1 0 4 1 2 3 0 0 0	1 0 1 2 0 1 0 0 1 1 4 1	-337 -93* 939 -7317	0.5 0.5 0.5 0.0 0.4 0.6 0.0 0.0 0.2	0.00.06.09.00.00.00.00.00.00.00.00.00.00.00.00.	3.7 -5.6 6.6 0.2 1.6 -9.9 0.8 -11.4 11.4 10.1 4 9.5 5.6 9.7 6.4 2.2 -9.6 7.5 2.1 5.4 -2.2 9.1 5.2 7.5 -4.9 5.5 -2.0 1.6 -9.8 1.4 -10.3
12	o	10 20 21 22 23 27 0 1 2 3 4 5 6 7	0 10* 7 7 8 1 7	33 7 6 10 11 0 33 32 5 6 3	161121032210001	0 1 2 0 1 2 0 1 1 1 0 1 1 0	7 7 -1 1 -7 -9 13* 7 7 -11 3 17	0.8 0.6 0.5 0.4 0.6 0.9 0.8 0.2 0.0 0.0	0.0 0.1 0.9 0.0 1.0 0.4 0.0 1.0 0.7 0.6 0.7	7.2 1.5 9.1 -4.9 5.5 -2.0 1.6 -9.8 1.4 -10.6 12.3* 11.6 7.9 2.9 8.5 4.0 1.0 -11.0 7.4 1.8 5.1 -2.9 7.9 6.7 5.1 -2.9 8.5 -3.6
13	21	20 21 22 23 27 21 0 1 23 4 5 6	9464511* 11* 558716	4 6 7 11 7 1	5 1 1 1 0 1 4 1 1 1	0 2 2 0 5 0 0 1 1 1	551 -19-11 -11-17-17-11	0.5 0.6 0.5 0.6 0.6 0.7 0.3 0.9 0.2 0.0	0.440000002190	5.2 -2.7 1.4 -9.8 3.6 -5.9 11.6* 10.2* 9.9 6.8 5.3 -2.5 9.4 5.7 8.8 4.6
14	21 21	6 7 10 20 22 27 21 0 1 2 3 4 5 6 7	1615587120* 97765161	73407972240813123527962488	0 1 6 1 2 1 0 1 1 5 4 4 2 0 0	3 0 0 2 0 1 3 1 0 0 0 0 1 0 0 0 1	-5 -1 9 -7 -3 11* -11 -1 -5	0.0 0.6 0.8 0.7 0.7 0.0 0.6 0.5 0.9 0.9 0.9 0.0 0.0	0.7 0.0 0.0 0.7 0.9 0.9 0.0 0.0 0.0 0.0	2.8 -7.3 5.6 -1.8 7.5 2.0 9.9 6.6 8.1 3.3 1.8 -9.4 3.1 -6.8 11.6* 10.1*
15	2! 21	7 10 22 23 27 21 22 0 1 2	765161455230** 107464	624881 14857	0 2 6 2 1 0 2 2 2 1	1 0 2 2 2 0 0 0 0 2 2	105 500 111 115 -001	0.1 0.6 0.9 0.6 0.5 0.5 0.5 0.6 0.0	0.8 0.4 0.7 0.1 0.0 0.0 0.0	9.5 6.0 9.3 5.7 8.9 4.9 8.2 3.3 6.6 0.2 1.0 -11.0 6.0 -1.0 2.1 -3.8 4.4 -4.2 7.7 2.4 2.1 -6.8 4.7 -3.6 11.0 9.1 11.3* 9.7* 7.9 2.9 4.6 -1.5 5.4 -2.3

				# 7						
16	21	4567003710012345670	31 15 86 30 11* 65 76 24 1	788703210137557796	0 0 0 0 5 1 1 0 1 4 1 0 0 2 0 0	2 4 1 0 3 7 3 0 0 0 1 2 2 2 3 1	-1 -3 -3 -1 13* -7 -1 -1 -1 -5 1	0.000.000.000.0000.0000.0000.0000.0000.0000	0.1 0.5 0.8 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	-1.22 -1.22 -1.22 -1.10 -1.32 -1.10
17	0	10 20 22 23 27 7 0 1 23 4 5 6	5689219* 887574	1 2 3 8 9 3 0 3 2 2 7 5 4	6 1 1 0 1 5 2 3 1 1 0 0	02023000030150	11* 97 -57 13* 79 -1357	0.9 0.6 0.9 0.7 0.0 4 0.8 0.7 0.8 0.2 0.0	0.6 0.7 0.0 0.0 0.0 0.0 0.0 0.7 0.7 0.7	11.6* 10.1* 8.3 -2.4 8.0 -2.4 8.0 -7.9 -7.23 -7.23 -7.23 -7.23 -7.23 -7.23 -7.23 -7.23 -7.23 -7.23 -7.23 -7.23 -7.23 -7.23 -7.32 -7.32 -7.33 -7.
18	0	10 20 21 22 27 07 1 23 45 60 20	44251099 7746768	3 7 10 5 9 12 0 3 4 3 3 4 5 2	6 1 2 1 0 4 1 2 3 1 0 0	0 1 0 1 2 1 0 0 0 3 3 2 2 3	7 -17 -51 -1137 -57 75 9	0.7 0.5 0.4 0.3 0.5 0.0 0.6 0.7 0.6 0.0 0.0	0.0 0.2 0.0 0.0 1.0 0.9 0.0 0.0 0.9 1.0 0.3 0.3	7.3 1.6 5.3 -2.4 2.4 -8.1 6.4 -0.1 1.6 -9.8 0.2 -12.5 11.9* 10.8* 9.6 6.2 7.9 2.8 6.5 -0.1 7.3 1.5 8.5 4.0 7.6 2.3
19	0	10 21 22 23 27 0 1 2 3 4 5 6 7	522420 10* 10* 10*	2 3 8 10 7 8 11 0 2 2 1 7 10 4 3	5 1 1 1 0 3 1 3 2 0 0	0 2 0 1 2 2 0 0 1 1	7 -3 -7 -13 -9 13* -9 11 -757	0.6 0.4 0.4 0.5 0.0 1.0 0.7 0.3 0.0 0.0	0.0 0.3 0.0 0.7 1.0 0.0 0.0 0.0 0.4 0.9	2.7 -7.6 0.1 -12.8 12.4* 11.8* 10.8 8.6 8.9 4.9 9.6 6.3 5.4 -2.1 2.3 -9.3 6.5 0.0 9.4 5.7
20	0	10 20 21 22 23 27 1	7 4 2 1 4 1 4	338968620	1 6 1 1 1 0 0	125202223300	7 -3 -5 1 -3 1	0.9 0.6 0.6 0.1 0.6 0.0	0.0 0.1 0.8 0.4 1.0 0.9	6.7 0.4 4.5 -4.1 2.0 -9.0 5.4 -2.2 2.2 -3.5 4.9 -3.2 11.0 9.0 12.4 11.9*

40 .		•	•							
		2 3	9	3	1	Q.	7	0.7	0.0	9.7 6.4
		3	9	2	2	0	9	0.3	0.0	9.4 6.1
		4	4	7	1	1	- 1	0.1	0.3	4.7 -3.5
		5	1	10 .	0	2	-7	0.0	0.4	2 2 -2 5
		6	3	7	0	2 3 1	- 1	0.0	0.7	4.7 -3.6
		7 10	9	7 3 4	0	1	- <u>1</u>	0.0	0.7	9.3 5.5
		10	4	4	5	0	5	0.5	0.0	5.9 -1.2
		20	4	7	1	1 2 0	- 1	0.7	0.0	2.3 -2.5 4.7 -3.6 9.3 -5.5 5.9 -1.2 5.7 -1.6 2.4 -8.1 6.5 0.0
		21	1	9	1	2	-5	0.6	0.6	2.4 -8.1
-		22	6	6	1	0	1	0.5	0.0	6.5 0.0 1.1 -10.8 5.8 -1.5 12.5* 12.0* 11.0 9.0 10.0 7.0
		23 27	0	10	1	2	<del>-</del> 7	0.6	0.8	1.1 -10.8 5.8 -1.5 12.5* 12.0* 11.0 9.0
		27	4	5	0		3	0.0	1.0	5.8 -1.5
21	Ģ	0	11*	0 2 3 2	2 0	0	13*	0.8	0.0	12.5* 12.0*
	0	1	11*	2	0	Ċ	9	0.0	0.0	11.0 9.0
		Z	10	3	0	0	7	0.0	0.0	10.0 7.0
		2 3 4	8	2	1	2	9	0.3	0.3	10.0 7.0 9.9 6.8
		4	4	8	0	1	-3	0.0	0.8	4.2 -4.6
		5	1	10	0	2 1 2 3 1	-7	0.0	0.8 0.7	4.2 -4.6 2.1 -8.9 4.2 -4.6 8.1 3.2 5.7 -1.6 6.7 0.5
		6 7	3 8	7	0	3	- 1	0.0	0.9	4.2 -4.4
		7	8	4	0	1	5	0.0	0.9	8.1 3.2
		10	4	4	5	0	5	0.5	0.0	5.7 -1.6
		20	5	6	1	1	1	0.7	0.0	6.7 0.5
		21	2	8	1	1 2 0	-3 -3	0.6	0.3	4.1 -4.9
		22	4	٤	1	Ō	-3	0.5	0.0	4.5 -3.9
		23	9	10	1	2 4	-7	0.6	0.3	1.1 -10.3
		27	5	4	0		5	0.0	1.0	0.7
22	1 1	0	10*	0	3	0	13*	1.0	0.0	12.5* 11.9* 11.0 9.1
	1	1	10*	0	2	1	13*	0.0	0.0	11.0 9.1
		2 3	9	4	0	0	5	0.0	0.0	9.0 5.0
		3	9	3	1	0	7	0.3	0.0	9.3 5.6 2.0 -9.0 1.3 -9.4 3.9 -5.4 6.9 0.9 6.2 -0.7 8.8 4.6 5.9 -1.1
		4	2	11	0	0	-9	0.0	0.0	2.0 -9.0 1.3 -9.4 3.9 -5.4 6.9 0.9
		5	1	11	0	1	-4	0.0	0.2	1.3 -9.4
		6	3	٠	0	1	-5	0.0	0.2	3.9 -5.4
		7	5	6	2	0	1	1.0	0.0	6.9 0.9
		10	4	3 <b>4</b>	6	0	7	1.0	0.0	6.2 -0.7
		20	8	4	1	0	5	0.8	0.0	8.8 4.6
		21	5	6	1	1	1	0.6	0.7	5.9 - 1.1
		22	3	9	1	0	-5 -5	0.0	0.0	3.0 -6.9
		23	1	9	1	Z	-5	0.7	0.8	2.1 -9.9
23	21	27	8 11*	3	0	0 2 2 0	7	0.0	1.0	8.8 4.6 5.9 -1.1 3.0 -6.9 2.1 -8.9 8.7 4.4 11.7* 10.5* 11.0 9.0 7.3 1.5
23	21	21	9	1	1 3 2		11*	0.7	0.0	11./* 10.5*
		1	6	5	2	0	11* 3	1.0	0.0	11.0 9.0 7.3 1.5
		2	8	4	1	ŏ	5	0.7	0.0	9.7 4.3
		2 3 4	ė	2	i	í	5 7	0.9	0.7	8.7 4.3 9.2 5.4 3.6 -5.7
		Δ	3	3 9	i	ò	~Ś	0.6	0.0	2 4 -5 7
		5	ĭ	10	ō	ž	-7	0.0	1.0	9.2 5.4 3.6 -5.7 1.7 -9.6
		5	2	9	Ď	0 2 2	-5	0.0	0.4	3.3 -6.4
		7	4	8	1	ō	-3	0.1	0.0	4.1 -4.8
		10			7	ō	5	0.4	0.0	3.3 -4.4
		20 22 23	2 8 6	4 2 5 9 3 0 2 4	7 1	0 2	9	0.9	0.6	3.3 -6.4 10.0 6.9
		22	6	5	1	1	3	0.7	1.0	6.7 0.5
		23	0	9	1	3	-5	0.8	1.0	1.4 -10.2
		27	5	3		1 3 5 0	7	0.0	0.6	1.4 -10.2 9.0 5.0 12.6* 12.2* 11.0 9.0 9.0 5.0
24	0	0	11*	o	0 2 0	0	13*	0.8	0.0	12.6* 12.2*
	0	1	11 <b>*</b> 9	2	0	0	9 5	0.0	0.0	11.0 9.0
		2	9	4	Ō.	0	5	0.0	0.0	9.0 5.0
		1 2 3 4 5 6	9	1	1	2	11	0.2	0.9	9.7 6.4 3.0 -7.0 2.1 -8.8
		4	3	9	O.	1	-5	0.)	1.0	3.0 -7.0
		5	1	10	9	2	-7	0.0	0.7	2.1 -8.8
		6	3	10 7	0	2 3 1	- 1	0.0	0.9	4.0 -5.0
		7	8 4	4	0	1	5	0.0	0.1	8.9 4.9
		10	4	4	5	0	5	0.7	0.0	5.9 -1.3
		20	7	5 8	1	0	3 -3	0.8	0.0	7.8 2.5
		21	2	8	1	2	-3	0.6	0.3	4.2 -4.6
		22	4	8	1	0	-3	0.3	0,0	4.3 -4.4

25 26	1 1	237 0 1 2 3 4 5 6 7 0 0 1 2 2 3 7 1 0 1 2 3 4 5 6 7 0 0 2 2 3 7 1 0 1 2 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	05 11* 89 2138484409* 108699312368603 FIFIED	10502531109544778004122544881880225106 SETS	102001000051111023200100171210	230000021000110200000113102024	-733* -733* -753551375553993371	0.6000000000000000000000000000000000000	0.7	9.0 11.2 10.4 6.1 9.0 3.7 1.6 3.2 3.3 4 10.1	# 12	0112.99.4006989048800685981803
UNIQ	UE 1ST ED 1ST	PLACE	YVO		CVOTE 12 6 8	WV	0TE 19 0 7	BVOT 1	E .9 0 7			
HYPE #SET 1 2 6 7 8 2	RPLANE	TION SU POI YVOTE 12 12 4 3 9	NTS IN	THE F	IRST S	ET	YVOTE			SECOND E GVOT		
26 27 28 29	2 3 2 4 2 6 2 27	0 1 1	1 0 0	0 0	0 0 0	0. 100. 100.	1		0	0	0	100.
36 2 37 2	11 2 11 3 11 4 11 7	9 8 9	0 1 0 0	0 0 0	0 0 0	100. 89. 100.	1	l	0	0	0	190.
43 2 44 2	1 22 1 5 1 23	9 5 9 0 4	0 0	3 0 0	0	56. 100. 100.	1		0	ç	0	190.
46 47 48 49 54 55 56	1 7 1 22 1 5 1 23 0 7 0 22 0 5 0 22 2 20	4 4 12 12	1 0 0 0 0 0 0	300000000000000000000000000000000000000	0 0 0 0 0	0. 100. 100. 100. 100. 100. 100.	1	l	0	0	0	100.

61	1	2 3	3	0	1	Ó	75.	0	0	1	0	0.
62	1	3	4	0	0	0	100.					
63	1	4	4	0	0	0	100.					
64	2	10	1	0	0	0	100.					
67	0	2	7	0	5	Ō	58.	0	0	1	Q.	0.
68	0	2 3	0	Ó	12	Ó	ŏ.	•	•	•	•	٠.
69	0	4	7	9	5	0	<b>5</b> 8.					
70	21	1	8	1	0	0	89.	i	9	0	0	100.
71	21	20	8	1	0	0	89.	1	Ò	Ö	ō	100.
-72	1	20	4	0	Ó	0	100.	-	-	-	-	
73	21	10	0	Ó	9	Ó	0.					
75	0	20	12	0	0	0	100.					
76	21	0	0	9	0	0	0.	9	0	0	0	100.
77	1	10	4	0	0	0	100.	-	-	-	-	
78	1	0	0	1	3	0	0.	1	0	5	0	17.
79	0	10	0	0	12	0	0.				-	
80	2	7	0	1	0	0	0.	1	0	Ō	Ů	100.
81	2	22	1	0	Ó	0	100.	_	•	•	•	
82	2	5	1	0	0	0	100.					
83	2	23	1	Ó	0	0	100.					

TIME USED: 8.54 SECONDS, COMPLETED AT 16.75 HOURS ENTER 0,1 AS THERE ARENT, ARE MORE CASES

FORTRAN STOP \* EXIT

CASEY

VAX4>

Job terminated at 22-MAY-1987 16:45:08.61

Accounting information: Buffered I/O count: 54
Direct I/O count: 110
Pase faults: 1351
Charsed CPU time: 0 00:00:07.23

Peak working set size: 1206 Peak mase file size: 1783 Mounted volumes: Elarsed time:

0 00:00:13.89

```
VAX4> RUN EFPLBN
EFACHY (EMPIRICAL FLUTTER ANALYSIS BY CALACTIC HYPERPLANES)
RUN ON 10/14/87 AT 14.63 HOURS ON TSHARE
ENTER NUMBER & NAMES OF DATA FILES, WORDS/RECORD, Y/N TO CLEARFILES
1 755777B7 20 7Y7
%FOR-F-INPCONERR, input conversion error
 unit 5 file SYS$INPUT:.;
user PC 00009BA1
%TRACE-F-TRACEBACK, symbolic stack dump follows
             routine name
                                                       rel PC
module name
                                             line
                                                                abs f
                                                      00014002
                                                               000149
                                                      00014BBF
                                                               000141
                                                              0001 M
                                                      83001000
EFBLBN$MAIN
              EFBLBNSMAIN
                                                      000001A1 00009I
                                              117
VAX4> RUN EFBLBN
EFACHY (EMPIRICAL FLUTTER ANALYSIS BY GALACTIC HYPERPLANES)
RUN ON 10/14/87 AT 14.64 HOURS ON TSHARE
ENTER NUMBER & NAMES OF DATA FILES, WORDS/RECORD, Y/N TO CLEARFILES 1 '55777B' 20 'Y'
 NAME GALACTIC HYPERPLANE FILE
'FLPLANES'
ENTER 0,1 TO NOTPERTURB, PERTURB INPUT DATA FILES
0
 NAME OUTPUT FILE FOR SET ASSIGNMENTS . ' TO PRINT
%FOR-F-INPCONERR, input conversion error
 unit 5 file SYS$INPUT:.; user PC 00009DED
ZTRACE-F-TRACEBACK, symbolic stack dump follows
module name
             routing name
                                             line
                                                       rel PC
                                                      00014002
                                                               000140
                                                      00014885
                                                               00014E
                                                      00010D69 000; E
EFBLBN#MAIN
              EFBLBN$MAIN
                                              154
                                                      000003EB
                                                               00009E
VAX4> RUN EFBLEN
EFACHY (EMPIRICAL FLUTTER ANALYSIS BY GALACTIC HYPERPLANES)
RUN ON 10/14/87 AT 14.66 HOURS ON TSHARE
```

ENTER NUMBER & NAMES OF DATA FILES, WORDS/RECORD, Y/M TO CLEARFILES

1 '55777B' 20 'Y'

NAME GALACTIC HYPERPLANE FILE

```
ENTER 0,1 TO NOTPERTURB, PERTURB INPUT DATA FILES
 NAME OUTPUT FILE FOR SET ASSIGNMENTS ,' ' TO PRINT
 ENTER N (LE
                        14) THEN ID OF N SETS TO BE EXCLUDED
0 0
 ENTER N. THEN N PAIRS OF IDS TO BE LABELED AS THE FIRST
0 0
 ENTER N THEN THE N HYPERPLANES TO BE USED (O O FOR ALL)
0 0
 ENTER 0 OR 1 TO NOTWRITE OR WRITE THE FOLLOWING OUTPUT OPTIONS
 HYP, PTS, VOT, ASS, ASP, ASC, HPT
0111111
 ENTER N (LE 20) THEN N RECORD NUMBERS FOR HYPERPLANE/POINT OUTPUT
123
 P VOTE CONFIDENCE LEVEL = 0.5000000
 RELIABILITY INDEX PER SET
ID 0 1 2 3 4 5 6 7 10 20 21 22 23 27 X 0.71 0.73 0.77 0.78 0.71 0.31 0.08 0.77 0.59 0.79 0.73 0.67 0.57 0.17 5
  PT ACTID CANID YVOT NVOT OVOT GVOT CVOT MXX0 MXXG WVOTE BVOTE PVOTE
 DATA FROM FILE 55777B
 POINT NUMBER
                  67.50000
  432.0000
                                   904.3000
                                                   19.50000
                                                                   2.790000
  1.321000
                  49.91700
                                                                   1.700000
                                 0.6860000
                                                   10.36900
 0.6650000
                  1.141000
                                 0.1300000
                                                   937.0000
                                                                   4.629000
  1.770000
                 0.0000000E+00 0.0000000E+00
                                                   21.00000
                                                                   21.00000
                                         432, RECCRD #
 HYPERPLANE VOTES FOR POINT #
 HYPL# SETID
                           DISTANCES NORMAL TO FLANES
                                                                    SETID
   1
                         27.21380
                                               27.213815
                                                          61.63589
   2
        27
                     C
                         24.01917
                                               24.020011
                                                          56.53007
                                                                        0
   3
         27
                         -1.04922
                                   -0.85887
                                               -0.402350
                                                                        6
          6
                         -0.18576
                                               -0.185741
                                                          -0.11681
                                                                        10
   5
         27
                          0.10979
                                               0.10980]
                                                            0.13346
                                                                        10
   6
          6
                         -0.14940
                                               -0.14234[
                                                            0.06251
                                                                        1
   7
         27
                         -2.28858
                                               -2.28303[
                                                          -2.23948
                                                                        1
   8
          6
                      1
                          0.07854
                                                0.15722[
                                                            0.26433
   9
         27
                         -2.95282
                                               -2.949395
                                                          -2.92339
                                                                        21
  10
          6
                         -1.98267
                                   -1.94685
                                               -1.923265
                                                                       20
         27
  11
                         -2.03761
                                   -1.96018
                                              -1.924180
                                                                        20
  12
         22
              0.336291
                          0.52278
                                                0.57952[
                                                                        7
  13
          5
                         -1.06194
                                               -1.04936E
                                                          -1.02470
  14
          6
                                               -1.25879[
                         -1,28627
                                                          -0.97135
                                                                         7
```

-1.46843

-1.42749

-1.371550

15

27

4

3

	•					_	
16	23	3	-2.51894	-2.31391	-2.30384[		7
17	5	3	0.03803		0.03929[	0.57164	22
18	6	3	-0.61770		-0.50018[	-0.43982	22
19	27	-0.951901	-0.93183		-0.91507[		22
20	23	3	-1.69360		-1.67325[	-1.42078	22
21	6	-0.951901	-0.59412		-0.58419[		5
22	27	-0.951901	-0.93183		-0,58419[		5
23	23	3	-2.68281	-2.49879	-2.25038[		5
24	23	1	-2.10593	-1.77685	-1.509220		6
25	23	1	0.73684		0.93183[	0.95190	27
26	3	C	-0.21974		-0.219103	-0.21490	2
27	4	-1.063493	-0.99242		-0.97353[		2
28	6	1	-2.15086		-2.09786[	-2.08703	2
29	27	1	-0.49929		-0.42550[	-0.28202	2
30	4	-1.134021	-1.07920		-1.06043[		3
31	6	1	-1.99838		-1.88772[	-1.79691	0
32	27	1	-2.60251		-2.55897[	-2.49017	3
33	6	1	1.10985	1.11110	1.11351[		4
34	27	1	-0.61296	-0.40740	-0.36990[		4
35	2	ľ	-0.39357		-0.39357]	-0.38708	21
36	3	ŗ	0.13106		0.131071	0.15767	21
37	4	£.	0.13857		0.13857]	0.14462	21
38	7	t	0.12349		0.128501	0.18533	20
39	22	0.33293]	0.34155		0.36176[		20
40	5	3	-0.10342		-0.09257[	0.40926	20
41	23	1	-0.54755	-0.53242	-0.47550[		20
42	7	3	0.37558		0.40575[	0.43649	21
43	22	0.20672[	0.20682		0.20925]		21
44	5	1	0.13619		0.40553[	0.55748	21
45	23	3	-2.27999		-2.25574[	-2.02524	21
46	7	C	-0.02355	-0.02090	-0.01963]		1
47	22	0.307293	0.32760		0.32809[		1
48	5	3	-0.13876		-0.13876[	0.28776	1

49	23	3	0.20178	0.21807	0.27575[		1
50	7	[	-0.23324		-0.206131	-0.10642	10
51	22		0.10292	0.10609	0.11091]		10
52	5	3	-1.97558		-1.97556[	17.82939	10
<b>5</b> 3	23	C	0.27362	0.36437	0.55480]		10
54	7	0.790668	0.82410		0.927613		0
55	22	Ċ	21.73051		21.73053]	50.19141	Q.
56	5	1	28.22050		28.220516	65.47410	ō.
57	23	0.25481]	0.25994		0.25999[		o
58	20	-0.520301	-0.50071		-0.50071[		2
59	20	-0.08324[	-0.05049		-0.050493		3
60	4	0.007791	0.01297		0.01298[		20
61	2	0.47075[	0.51116		0.548303		1
62	3	0.28201[	0.29632		0.296561		1
63	4	£.	0.30130		0.301201	0.30340	1
64	10	-0.182900	-0.16497		-0.16340]		2
65	10	0.14991[	0.24728		0.247331		3
66	4	7	0.38866	0.48291	0.499491		10
67	2	0.09512[	0.15425		0.221601		6
88	3	0.07739[	0.12111		0.258281		0
69	4	C	0.19506		0.19941]	0.20029	0
70	1	C	-0.17130		-0.171303	-0.15081	21
71	20	C	-0.07224		-0.042463	-0.03696	21
72	20	0.23260]	0.27950		0.27950[		1
73	10	C C	-0.43299	-0.30725	-0.242241		21
74	10	C	-0.41106	-0.22954	-0.18058]		20
75	20	C	23.07658		24.386331	71.27054	0
76	0	-71.104301	-20.16585		-20.16562[		21
<b>7</b> 7	10	0.437995	0.49614		0.528903		1
78	0	C	0.2336:	0.23428	0.256801		1
79	10	ĵ.	-0.23210	-0.03140	0.02505]		0
80	7	C	0.07367		0.073671	0.10607	2
81	22	2	0.39447		0.411953	0.44982	2

	••	•			_			
	82	5	3	0.74082		0.818860	0.85541	Z
	83	23	3	-2.33588	-2.06975	-1.99848[		2
	84	7	1	0.15241		0.16586[	0.38493	3
	85	22	-0.26118]	-0.15288		-0.131430		3
-	86	5	-2.180223	-2.17010		-2.14888[		3
	87	23	3	-2.15842	-1.89041	-1.85990[		2
	88	4	0.627471	0.63751		0.63769[		7
	89	4	1	0.67205		0.679875	0.75043	22
	90	5	3	1.85836		1.86168[	2.25662	4
	91	23	3	-2.45007		-2.263190	-2.24415	<b>4</b>
	432	21	21 10* 0 7 1 4 2 8 3 5 4 6 5 1 7 3 10 7 20 5 22 9 23 1 27 3	4 2 4 0 7 0 4 1 11 0 8 0 7 1 0 6 4 1 3 1 4 0	3 5 0 7	0.7 0.0 1.0 0.0 0.7 0.8 0.0 0.2 0.0 0.1 0.1 0.7 0.0 0.6 0.0 0.7 0.2 0.6 0.9 0.0 0.8 0.8 0.6 0.0 0.7 1.0 0.0 0.8	10.7* 8.3* 8.8 4.5 4.9 -3.1 8.8 4.6 5.9 -1.2 7.3 1.7 1.4 -10.1 2.9 -7.2 4.7 -3.6 9.3 5.7 7.3 1.5 9.6 6.2 4.6 -3.7 4.8 -3.5	8.2+ -0.5 -1.83 -0.5 -1.83 -0.5 -1.83 -0.5 -1.9 -1.9 -1.9 -1.9
	POINT 434. 1.32 0.908 1.99	0000 1000 0000	67.50 60.99 1.282	600 (000) (000)	910.4000 0.9560000 0.1000000 0.0000000E+	17.566 12.164 1242.0 00 1.0006	100 7. 000 5.	079000 920000 272000 000000
	HYPER HYPL# 1		VOTES FOR	DISTAN	434, CES NORMAL	RECORD # TO PLANES 27.213810		ETID O
	2	27	ι	24.01917		24.020011	57.06602	0
	3	27	3	-1.04922	-0.96216	-0.40235[		٤
	4	6	£.	-0.18576		-0.18574]	-0.08219	10
	5	27	C	0.10979		0.109801	0.14937	10
	6	6	1	-0.14940		-0.14234[	-0.01629	1
	7	27	3	-2.28858		-2.28303[	-2.25563	1
	8	6	1	0.07854	0.13383	0.15722[		21
	9	27	1	-2.95282	-2.95179	-2.94939[		21
	10	6	3	-1.98267		-1.923260	-1.88979	20
	11	27	3	-2.03761		-1.924180	-1.89643	20
	• •	~~	•	^ =				-

12	44	1	0.022/8		0.579521	0.58/83	7
13	5	-1.173453	-1.06194		-1.04936[		7
14	6	-1.307 <del>5</del> 81	-1.28627		-1.25879[		7
15	27	-1.47943]	-1.46843		-1.371550		7
16	23	1	-2.51894		-2.30384[	-2.19560	7
17	5	1	0.03803		0.03929[	0.54909	22
18	6	1	-0.61770		-0.500180	-0.20800	22
19	27	-0.98471]	-0.93183		-0.915070		22
20	23	1	-1.69360		-1.673260	-1.52027	22
21	6	-0.984713	-0.59412		-0.58419[		5
22	27	-0.984713	-0.93183		-0.58419[		5
23	23	3	-2.68281	-2.37346	-2.250380		5
24	23	1	-2.10593	-1.64220	-1.50922[		4
25	23	3	0.73684		0.931830	0.98471	27
26	3	ŗ	-0.21974		-0.218103	-0.21729	2
27	4	1	-0.99242		-0.97353[	-0.90537	2
28	6	1	-2.15086		-2.097865	-2.00979	2
29	27	3	-0.49928		-0.42550[	-Q.37283	2
30	4	1	-1.07920		-1.06043[	-0.99663	3
31	6	1	-1.99838		-1.887720	-1.73158	3
32	27	1	-2.60251		-2.55897[	-2.55111	3
33	6	1.009351	1.10985		1.113510		4
34	27	1	-0.61296	-0.57065	-0.369900		4
35	2	-0.42045[	-0.39357		-0.39357]		21
36	3	0.111830	0.13106		0.13107]		21
37	4	0.11474[	0.13857		0.13857]		21
38	7	0.03367[	0.12849		0.12850]		20
39	22	1	0.34155		0.36176[	0.38486	20
40	5	1	-0.10342		-0.09257[	0.48003	20
41	23	·1	-0.54755		-0.47550[	-0.31534	20
42	7	0.345741	0.37559		0.40575[		21
43	22	£.	0.20682		0.209251	0.21963	21
44	5	1	0.13619	0.34883	0.40553[		21
*	^^	•					

40	۷3		-2.27999		-2.25574[	-1.87820	21
46	7	C	-0.02355	-0.01999	-0.01963]		1
47	22	1	0.32760		0.32808[	0.34796	1
48	5	3	-0.13876		-0.13876[	0.26276	1
49	23	1	0.20178		0.27575[	0.51205	1
<b>5</b> 0	7		-0.23324	-0.21929	-0.20613]		10
51	22	0.102290	0.10292		0.11091]		10
52	5	1	-1.97558		-1.97556[	19.06431	10
53	23	C	0.27362	0.37969	0.554801		10
54	7		0.82410		0.927613	1.01779	o
55	22	ι	21.73051		21.73053]	51.02850	0
56	5	3	29.22050	•	28.22051[	66.49910	0
57	23	1	0.25994		0.25999[	0.26782	ġ
58	20	3	-0.50071		-0.50071[	-0.45170	2
59	20	C	-0.05049		-0.050493	-0.04300	3
60	4	3	0.01297		0.01298[	0.01303	20
61	2	£	0.51116	0.54682	0.54330]	•	1
62	3	C	0.29632		0.296563	0.30376	1
63	4	ŗ	0.30130		0.301301	0.31284	1
64	10	1	-0.16497		-0.163401	-0.15443	2
65	10	C	0.24728		0.24733]	0.28322	3
66	4	t	0.38866		0.499491	0.52118	10
67	2	ĵ.	0.15425	0.20174	0.221603		Q.
68	3	t	0.12111	0.19805	0.25828]		0
69	4	C	0.19506		0.199413	0.20218	ō.
70	1	-0.217340	-0.17130		-0.17130]		21
71	20	C	-0.07224	-0.06846	-0.04246]		21
72	20	3	0.27950		0.279500	0.31149	1
73	10	t	-0.43299	-0.32170	-0.242243		21
74	10	C	-0.41106	-0.24596	-0.18958]		20
75	20	t	23.07658		24.386331	69.00265	0
76	0	-69.88106]	-20.16585		-20.16562[		21
77	10	τ	0.49614		0.528001	0.56654	1
70	^		2 22211				

10	v	ı	U.23	301	0.238	370	0.2	2680]	÷		1	
79	10		-0.23	210	-0.039	748	0.0	2505]			0	
80	7		0.07	367			0.0	7367]	0.08	325	Z	
81	22		0.39	447			0.4	1195]	0.51	808	2	
82	5	1	0.74	082			0.8	1886[	1.09	217	2	
83	23	1	-2.33	588			-1.9	9848[	-1.92	019	2	
84	7	1	0.15	241			0.1	6586[	0.21	590	3	
85	22	3	-0.15	288			-0.1	3143[	-0.11	144	3	••
86	5	1	-2.17	010			-2.1	4888[	-2.06	792	3	
87	23	1	-2.15	342			-1.8	5990[	-1.74	849	3	
88	4	:	0.63	751			0.6	37695	0.76	324	7	
89	4	:	0.67	205			0.6	7987[	0.79	468	22	
90	5	:	1.85	336			1.8	61680	2.26	121	4	
91	23	:	-2.45	007			-2.2	6319[	-2.12	894	4	
434	1 1	2 11 1 10 3 10 4 5 7 5 10 20 6 21 22 23 27	0 0 0 2 9 10 7 6 4 5 6 8 10	23410002522010	00001230003023	13*	0.3 1.0 0.4 0.0 0.0 0.5 0.5 0.6 0.6 0.6	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	11.8 10.4 3.2 1.9 4.2 5.6 5.8 7.6 4.5 5.0	9.7 11.2* 10.6 7.9 -6.7 -9.1 -4.6 -1.8 -1.3 2.2 -4.0 10.7 -0.2	9.1 9.3* 8.5 7.8 -3.9 -0.1 -0.1 -0.1 -0.1 -0.9 -7.0 0.1	
436 1.3 0.78	T NUMBER .0000 21000 10000 70000	61.2 1.52	3 19900 13700 19000 10900E+0	0	915.00 .82500 .14000	00 00		15.45 10.69 1091.	200	10 4.	430000 .98000 630000	+00
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2	27	1	24.01	917			24.0	20013	56.28	197	0	
3	27	•	-1.04	922	-0.74	537	-0.4	923 <b>5</b> [			6	
4	6	!	-0.18	576			-0.1	9 <b>57</b> :4]	-0.11	602	10	
5	27	f	0.10	979			0.1	0980]	0.20	062	10	
6	6	;	-0.14	940			-0.1	4234[	-0.00	193	1	
7	27	:	-2.28	858			-2.2	8303[	-2.28	075	1	
8	6	:	0.07	854	0.10	009	0.1	57220			21	

9	27	-2.984261	-2.95282		-2.94939[		21
10	6	3	-1.98267	-1.93160	-1.92326[		20
11	27	3	-2.03761	-1.93980	-1.92418[		20
12	22	3	0.52278		0.57952[	0.64997	7
13	5	-1.14850]	-1.06194		-1.04936[		7
14	6	-1.329211	-1.28627		-1.25879[		7
15	27	3	-1.46843	-1.42111	-1.371559		7
16	23	3	-2.51894		-2.303840	-2.23848	7
17	5	1	0.03803		0.039295	0.53499	22
18	6	3	-0.61770		-0.50018[	-0.47680	22
19	27	-1.028181	-0.93183		-0.91507[		22
20	23	3	-1.69360		-1.673260	-1.38210	22
21	6	-1.028191	-0.57412		-0.58419[		5
22	27	-1.028183	-0.93183		-0.58419[		5
23	23	1	-2.68281	-2.41077	-2.25038[	٠.	5
24	23	1	-2.10593	-1.62406	-1.50922[		٤
25	23	1	0.73684		0.93183[	1.02818	27
26	3	τ	-0.21974	-0.21829	-0.21810]		2
27	4	3	-0.99242		-0.97353[	-0.94390	2
28	6	3	-2.15086	-2.13301	-2.09786[		2
29	27	1	-0.49928		-0.42550[	-0.16251	2
30	4	1	-1.07920		-1.060435	-1.01920	3
31	6	1	-1.99838		-1.88772[	-1.84289	3
32	27	3	-2.60251		-2.55897[	-2.51132	3
33	6	1.042613	1.10985		1.113510		4
34	27	1	-0.61296	-0.37576	-0.36990[		4
35	2	-0.43080[	-0.39357		-0.39357]		21
36	3	0.10945[	0.13106		0.131073		21
37	4	0.09745[	0.13857		0.13857]	•	21
38	7	-0.06127[	0.12849		0.12850]		20
39	22	0.27551]	0.34155		0.361760		20
40	5	3	-0.10342		-0.09257[	0.41357	20
41	23	3	-0.54755	-0.52170	-0.47550[		20

42	7	0.28688]	0.37558		0.40575[		21
43	22	0.20391[	0.20682		0.20925]		21
44	5	1	0.13619	0.21161	0.40553[		21
45	23	1	-2.27999		-2.25574[	-1.95945	21
46	7	-0.02611[	-0.02355		-0.01963]		1
47	22	3	0.32760		0.32808[	0.35231	1
48	5	1	-0.13876		-0.13876[	0.25735	1
49	23	3	0.20178		0.27575[	0.49912	1
50	7	-0.241490	-0.23324		-0.20613]		10
51	22	נ	0.10292	0.10840	0.110911		10
52	5	1	-1.97558		-1.97556[	18.64163	10
53	23	£.	0.27362	0.38975	0.55480]		10
54	7	ŗ	0.82410		0.92761]	1.01804	0
55	22	ţ	21.73051		21.730531	50.41636	0
56	5	1	28.22050		28.22051[	65.64801	0
<b>5</b> 7	23	1	0.25994		0.25999[	0.27806	Q.
58	20	3	-0.50071		-0.50071[	-0.39168	2
59	20	ŗ.	-0.05049		-0.050493	-0.03389	3
60	4	-0.016753	0.01297		0.012985		20
61	2	C	0.51116	0.54625	0.54830]		1
62	3	[	0.29632		0.29656]	0.29966	1
63	4	τ	0.30130		0.301301	0.30437	1
64	10	C	-0.16497		-0.163403	-0.15692	2
65	10	נ	0.24728		0.247333	0.29545	3
66	4	£.	0.38866		0.49949]	0.52925	10
67	2	C	0.15425		0.221601	0.23032	0
88	3	[	0.12111	0.22635	0.25828]		o
69	4	נ	0.19506	0.19842	0.19941]		e
70	1	-0.24625[	-0.17130		-0.171301		21
71	20	-0.08035[	-0.07224		-0.042461		21
72	20	3	0.27950		0.27950[	0.34179	1
73	10	C	-0.43299	-0.32376	-0.242241		21
74	10	C	-0.41106	-0.25484	-0.18058]		20

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75	20		23.07658			74.29540	0
76	0	-75.668181	-20.16585		-20.16562[		21
77	10	C	0.49614		0.528001	0.56796	1
78	0	0.229538	0.23361		0.256801		1
- 79	10		-0.23210	-0.04142	0.025051		0
80	7	0.06159[	0.07367		0.073673		2
81	22		0.39447		0.41195]	0.50430	2
82	5	3	0.74082		0.81886[	0.91371	2
83	23	3	-2.33588		-1.99848[	-1.98292	2
84	7	0.14171]	0.15241		0.16586[		3
85	22	3	-0.15288		-0.131438	-0.05814	3
86	5	1	-2.17010		-2.148885	-2.11139	3
87	23	1	-2.15842		-1.859908	-1.81222	3
88	4	3	0.63751		0.63769[	0.74995	7
89	4	1	0.67205		0.67987[	0.69921	22
90	5	3	1.85836		1.86168[	2.28154	4
91	23	1	-2.45007		-2.26318[	-2.17224	4
<b>4</b> 36	0	0 104 1 104 2 8 3 9 4 4 5 1 6 3 7 9 10 4 20 2 21 1 22 6 23 0 4	0 3 2 2 2 2 7 1 10 0 5 0 4 5 7 1 9 1 0	0 13* 0 9 1 9 1 -1 2 -7 5 7 0 -15 1 -5 1 -5 1 -5 1 -5 1 -5 1 -5 1 -5	0.8 0.0 0.9 0.0 0.9 0.7 0.2 0.0 0.0 0.4 0.0 0.9 0.0 0.5 0.7 0.0 0.7 0.6 0.6 0.7 0.3 0.0 0.6 0.8 0.0 1.0	5.8 -1.4 9.5 6.0	8.1 5.7 6.1 -0.9 -2.1 0.5 0.1 -3.5 -0.5
438. 1.32 0.852	NUMB: .0000 11000 20000 2 2	ER 67.60 61.03 1.387	4 9000 8400 0 7000 0	919.0000 .8960000 .1200000 .0000000E+0 0 11 0 9 0 13* 0 11 1 -3 2 -7 3 -1 1 5 0 7 1 -1 2 -3	16.650 11.661 1181.0	.00 9. 900 <b>5</b> .	240000 440001 011000 000000 9.9* 5.7 8.9 8.1 -1.6 -2.4 -0.1 2.9 -0.8 -1.37

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